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Arnoldia Circulation Manager
The Arnold Arboretum
125 Arborway
Jamaica Plain, MA 02130-3500

Karen Madsen, *Editor*
Andy Winther, *Designer*

Editorial Committee

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Front cover: Puerto Purificación in the Sierra Madre Oriental, typical of the terrain negotiated by C. G. Pringle during his many plant-collecting expeditions in Mexico. Photograph by Rob Nicholson.

Inside front cover: Detail of the pergola in the rose garden at Maudesleigh, which Martha Brookes Hutcheson designed for Frederick S. Moseley. The Newburyport, Massachusetts, estate is now open to the public as Maudslay State Park. Photograph by the designer from her book, *The Spirit of the Garden*, 1923.

Inside back cover: The staff of the Arnold Arboretum photographed by Steve Gilbert.

Back cover: Woodcut illustration of the tiger flower, *Tigridia pavonia*, of southern Mexico, which has been known to Europeans since the earliest days of Spanish colonization. The hardiest of its congeners, *T. pringlei*, was found in 1887 by C. G. Pringle in central Mexico. Drawing from *Plantarum Historia* by L'Obel, 1576.

The Splendid Haul of Cyrus Guernsey Pringle

Rob Nicholson

A good active collector could make a splendid haul by putting in a season between Monterey and Saltillo including high mountain valleys not hard to reach but involving hard work and some risks. —C. C. Parry to Asa Gray, 1878

If Henry David Thoreau created the model for the New England activist-biologist, then perhaps its finest exemplar was a modest man from the hills of Vermont, Cyrus Guernsey Pringle, whose very name resonates with agrarian Yankee rectitude. Beginning in humble circumstances, Pringle went on to capture the attention of an American president, work with legendary Harvard botanists, and achieve a record of botanical fieldwork in Mexico that is unsurpassed today.

C. G. Pringle was born into a farming family in East Charlotte, Vermont, on May 6, 1838. After attending local secondary schools he enrolled at the University of Vermont in 1859, but soon had to return to the farm because of a death in the family. Pringle became an avid and skilled horticulturist at a young age, developing new strains of vegetables and reporting his results in horticultural journals. His hybridizing work with potatoes was so successful that a seedhouse in New York purchased the marketing rights for new varieties.

It was not his commingling of plant genes that first brought Pringle public attention, however, but his refusal to be drafted into the Union Army during the Civil War. A devout Quaker and pacifist, he refused to perform any task that would support the war effort, and although draftees could hire proxies to fill in for them, he also refused an uncle's offer to pay his commutation money. The diary of his wartime experience, published in 1918, portrays a strong-willed man of deep faith who remained uncompromising even while sometimes questioning his own zealotry.

When Pringle and two other Vermont Quakers were conscripted and sent to a military camp on an island in Boston harbor in late August of 1831, they were thrown into the guardhouse:

Here we are in prison in our own land for no crimes, no offence to God nor man: nay, more: we are here for obeying the commands of the Son of God and the influences of his Holy Spirit. I must look for patience in this dark day. I am troubled too much and excited and perplexed.

Over the next few weeks the prisoners were bullied by their military guards and urged even by other Quakers to agree to hospital work in lieu of active service. Still adamant, Pringle and his fellows were sent to Virginia, and guns were "thrust over our heads and hung upon our shoulders." As they marched toward the battlefield, Pringle had his first glimpse of the aftermaths of battle:

Seeing for the first time, a country made weary with war-blight, a country once adorned with groves and green pastures and meadows and fields of waving grain, and happy with a thousand homes, now laid with the ground, one realizes as he can in no other way something of the ruin that lies in the trail of a war. But upon these fields of Virginia, once so fair, there rests a twofold blight, first that of slavery, now that of war. When one contrasts the face of this country with the smiling hillsides and vales of New England, he sees stamped upon it in characters so marked, none but a blind man can fail to read, the great irrefutable arguments against slavery and against war too: and must be filled with loathing for these twin relics of barbarism, so awful in the potency of their consequences that they can change even the face of the country.



ARCHIVES OF THE PRINGLE HERBARIUM, UNIVERSITY OF VERMONT

For twenty-six years beginning in 1885, C. G. Pringle explored the flora of Mexico as a botanical collector for Harvard's Gray Herbarium. Although he hired assistants from both Vermont and Mexico, Filemon Lozano, seen here with Pringle, was his principal assistant from 1902 on.

Despite punishments that at one point included being staked to the ground in the summer sun, Pringle would not relent. Through the intervention of Isaac Newton, the Secretary of Agriculture, who was sympathetic to the Quaker cause, Pringle and his fellows were taken to Washington where their case was brought before President Lincoln. When Pringle's health began to deteriorate, Lincoln "was moved to sympathy on my behalf" and he was paroled on November 6.

After his three-month ordeal, Pringle returned to the family farm in East Charlotte and to his horticultural pursuits. He collected new varieties of grapes, currants, plums, tomatoes, and corn and resumed his hybridizing work with oats, wheat, tomatoes, plums, currants, gooseberries, and potatoes. During the 1870s he began to receive requests from the Boston area for specimens of native Vermont plants. The fern expert George Davenport of Medford, Massachusetts, for example, asked him for rare ferns from the Vermont woods. As a result of joining the Massachusetts Horticultural Society and other local botanical groups, Pringle met Asa Gray, the Harvard botanist who is often called the father of North American botany and whose family were to become lifelong supporters of Pringle's collecting efforts.

In 1880 Pringle was given three commissions to collect in the western United States. For Dr. Gray he was to collect plants of general botanic interest; for the U.S. Census Department, he was to explore the region's forests under the direction of the Arnold Arboretum's Charles Sprague Sargent and submit systematic, geographical, and economic data; for the American Museum of Natural History's Jesup Collection of North American Woods, he was to obtain large samples of wood, also under Sargent's direction. This work would keep him in the West from 1880 until the fall of 1882.

But during the course of Pringle's expedition, disputes arose between Sargent and Morris K. Jesup. Jesup was a wealthy New Yorker who had helped found the American Museum of Natural History and who was underwriting the Museum's effort to collect logs from every tree species in the United States. Jesup was depend-

ing on Sargent to direct his cadre of plant collectors on behalf of his wood collection, but the two men disagreed about which species to prioritize, and Jesup bristled at what he saw as extravagant expenses. As a result of these disputes Sargent began pressing Pringle for faster results, and after receiving a particularly bullying set of demands in October of 1882, Pringle cabled his resignation from Arizona. Explaining the conflict in a letter to Asa Gray, he wrote:

All season [Sargent] has goaded me on to completion of the Museum work, demanding impossibilities of me. He wished me to suspend in great measure (or entirely so) my own collecting, but offered no terms to compensate me. I suspended the Museum work for my own but thirty-three days in an entire season. Yet I am charged with unfaithfulness, incapacity, and even, as I understand it, with dishonesty. I recollect saying I should endeavor to please Mr. Sargent but that he should never make me his hack. I expect him to be terribly angry and give me a bad name [13 November 1882].

Gray continued as Pringle's patron and appointed him to the Gray Herbarium as a botanical collector. Gray wrote to Pringle saying that he preferred him to collect in Mexico, "in new ground." From then on, Pringle's arena for plant collecting would be Mexico, where he undertook 39 expeditions between 1885 and 1909, some lasting as long as ten months.

Pringle did continue to collect for Sargent occasionally. His field entry of November 10, 1907, reads:

Once again I spend another happy day on the mountainside above the Valley of Mexico . . . I collect a half dozen species in scores and cones of two pines for Professor Sargent, *P. teocote* and *P. pseudostrobus*.

And on four occasions Pringle shepherded through Mexico the eminent pine taxonomist George Russell Shaw, helping him find and identify a large number of Mexican pines, an exceedingly complex group. In 1909 the Arnold Arboretum published Shaw's work as *The Pines of Mexico*.

Cyrus Pringle always began his expeditions by boarding the train at Charlotte for the long trip



DRAWING BY A. F. LEITCH, GARDEN AND FOREST 2 (1889) 65

C. S. Sargent called *Pachycereus pringlei* one of the most interesting of Pringle's many Mexican discoveries. This drawing, made from a photograph taken on San Pedro Martin Island, shows what is surely one of North America's strangest and most remarkable forests. Sometimes more than thirty feet in height, *P. pringlei* is thicker and more ponderous than any other known cactus. Its flowers are scattered along the ribs, two or three feet from the top.

southward. He usually brought with him some young men from the local area as assistants, but these Vermont farmboys often wilted in the heat and difficult conditions of Mexico. 1886 was a particularly bad year, with two expeditions cut short so that Pringle could return home with sick assistants. His journal entry for Sunday, July 25, reads like a Vermonter's haiku:

The boys rested, I dried plants. Elmer getting worse. Fred disgusted with Mexico.

And on the following day, the surrender:

It having become apparent that Elmer could not stand the water, food, and climate of Mexico, it was decided best for him to return home: and as it seemed unsafe to send him alone, I could see no way but to take him home. Fred was ready to go, too, so we packed up and took the train in the evening.

It may be a measure of the botanist's iron constitution that three weeks after his return to Vermont he boarded a train for Mexico a third time that year. O. W. Barrett, a Vermont botanist who had collected with Pringle both in Mexico and Vermont, described the difficulties faced by Pringle and his assistants:

Usually, one Mexican helper would be left at the "base" to guard the property and to "change dryers," while an American assistant and perhaps a peon or two would "fare afield." The "base" might be a hacienda, a village inn, or a way station or water-tank on some railway. Changing the dryers two to four times a day, for 500 to 1,000 specimens, was a tedious, though not difficult task in the "Mesa" regions during the "dry season"; but in the "Tierra Caliente" valuable plant material sometimes "sweat" and blackened when hot dryers were insufficient. Nearly all the field work was done between nine and

noon; rains were liable to come on suddenly in the afternoon, and hail, terrific lightning, and blinding dust storms were not rare from the Rio Grande to Oaxaca, during most of the year. To tramp an hour, often over rough Indian trails carrying three to four quarts of water (in the largest canteen he could obtain), a plant press full of paper, and the lunch, was just a prelude to the three hours or more of active collecting over the chosen ground. Usually fifty to seventy specimens of each of the two to five species were taken each field day . . . [Davis 1936, 9–10].

Asa Gray had hired Pringle for a maximum salary of \$800 a year from the Gray Herbarium and \$200 from Harvard's Botanical Museum. After the death of Gray in January of 1888 and of Sereno Watson, curator of the Gray Herbarium, in 1892, support from Harvard disappeared, although Gray's widow, Jane Loring Gray, tided Pringle over with a personal loan, later burning the note in honor of her husband's memory. In 1893 Pringle was reinstated at Harvard with a reduced salary that fluctuated through the years. He supplemented his stipend in a variety of ways. Interestingly, he was an early worker in the field of bioprospecting, supplying specimens for the Instituto Medico Nacional de Mexico and for two American pharmaceutical firms, Eli Lilly & Co. and Parke, Davis and Co. In his diary, Pringle wrote that:

[T]he Instituto Medico Nacional is not a medical school but an institution endowed by the nation for botanical study and the investigation of the remedial values of plants by the physicians of the city. Extensive collections of plants are being gathered here, and there are laboratories for chemical and bacteriological study. I was gratified to find my Chihuahua herbarium preserved here intact and to learn it was esteemed of highest value, that it is to be kept separate, and to be extended by my present and future collections [7 September 1891].



Pringle in his herbarium, which was installed at the University of Vermont, Burlington, in 1902. At his death in 1911 the number of his specimens approached 155,000. "[He] liked to boast—his only jest of this sort—that he could call over 10,000 plant acquaintances, and a few botanical friends, by their proper names—though he was not certain as to who the president in Washington might happen to be" [O. E. Barrett in Davis 1936, 13].

More regularly, however, he earned extra income by selling mounted duplicates of his specimens to subscribers in the U.S. and abroad—thus the fifty to seventy specimens of each species mentioned by Barrett above. Pringle referred to this added burden in a letter of 1887:

Would not like to hear the howl of forty disappointed subscribers. Yet to travel free and light and to collect but a few specimens, how easy!

The list of recipients of Pringle's specimens, now in the archives of the Pringle Herbarium at the University of Vermont in Burlington, includes leading botanists and forty herbariums, among them the Smithsonian Institution, the British Museum, the California Academy of Science, the Royal Botanic Gardens at Kew and Edinburgh, the New York Botanic Garden, and the Missouri Botanic Garden. Sets were sold from each year's haul and although the numbers of specimens offered each year varied, the price was always ten cents per herbarium sheet. It was not a lucrative business, and Pringle struggled financially for most of his life.

The list of Pringle's Mexican specimens numbers 15,719 separate taxa, with representatives from 21 of the 30 Mexican states. In all of North America, he collected a phenomenal 500,000 herbarium specimens of 20,000 different species during the course of his thirty-five-year career. Because so much of his work was done in remote areas of Mexico, these included approximately 1,200 species new to science.

It is incongruous to find one of the world's best collections of Mexican flora in an old brick building that is surrounded by powdery snow through much of the year. The Pringle Herbarium at the University of Vermont holds many Mexican type specimens (the initial collection of a plant), and even today taxonomists working on the Mexican flora depend on loans from this repository to establish accurate generic relationships. For example, Pringle's herbarium contains five type specimens of *Tigridia*, a member of the iris family that is also known as clownflower because of its spectacularly colored blossoms. The botanist Elwood Molseed used these and many of Pringle's other *Tigridia* specimens to make taxonomic revisions of the genus in 1965. They were used again in 1994 by A. Espejo and A. R. Lopez-Ferrari, two researchers from the Universidad Nacional Autonoma Mexico. Given the availability of new technologies, Cyrus Pringle's complete collections may one day return to Mexico in digitized form via CD-Rom.

The journal that served as the principal outlet for Pringle's writings about the Mexican flora was *Garden and Forest*, which was published

weekly under the guidance of C. S. Sargent from 1888 to 1897. Its first issue included Pringle's notes on his discovery of extreme northern populations of *Begonia gracilis* var. *maritima* and *Dahlia coccinea*. Of the begonia he wrote:

When botanizing last September upon the cordilleras of North Mexico some two hundred miles south of the United States Boundary, I found growing in black mould of shaded ledges—even in the thin humus of mossy rocks—at an elevation of 7,000 to 8,000 feet, a plant of striking beauty, which Mr. Sereno Watson identifies as *Begonia gracilis*, HBK., var. *Maritima*, A.DC. From a small tuberous root it sends up to a height of one to two feet a single crimson-tinted stem, which terminates in a long raceme of scarlet flowers, large for the genus and long enduring. The plant is still embellished by clusters of scarlet gemmae in the axils of its leaves. Mr. Watson writes: "It was in cultivation fifty years or more ago, but has probably been long ago lost. It appears to be the most northern species of the genus and should be the most hardy." Certainly the earth freezes and snows fall in the high region, where it is at home [*Garden and Forest* 1 (1888): 7].

In addition to the more than thirty articles that Pringle wrote for *Garden and Forest*, other botanists, including Sereno Watson and the fern expert George Davenport, contributed articles based entirely on Pringle's Mexican collections. In fact, Pringle's work in Mexico and the plants he found there constitute a running theme throughout the life of the journal. In the sixth issue he began "The Forest Vegetation of Northern Mexico," the first of four series of articles on the Mexican flora; for those who plan to collect there, it is an invaluable primer. Another series, "Notes on the Ligneous Vegetation of the Sierra Madre of Nuevo Leon," shows Pringle writing for his armchair audience, people who would probably never follow in his tracks:

Across this Sierra Madre range the traveler by train of the Mexican National Railroad between Monterey and Saltillo is borne almost as swiftly and gently as though by the enchanted tapestry of the Arabian Nights. Looking backward and to the south-east as the train mounts the mesas of Garcia and nears the base of the mountains, he sees several successive ranges with serrated summits rising one above the other and receding

*Tigridia Pringlei*

THE Tiger-flower, the well known *Tigridis Pavonia*, a native of the valleys of southern Mexico, early attracted the attention of the Spanish conquerors, and became known by reputation under the name of *Tigridis flos* long before it had been seen by any botanist. It was first described by L'Obel (Lobelius) in his *Plantarum Historia*, published at Antwerp in 1576, where he gives a very rough but recognizable wood-cut of the plant . . . Hernandez also describes it in the *Historia Plantarum Navæ Hispaniæ* (1651), giving the same Latin name, *Flos tigridis*, and the Aztec name, *Oceloxochitl*. He speaks of it as growing in gardens and cultivated fields about the City of Mexico, as though it were cultivated both for its flowers and for its edible bulbs. . . . Upon the description by L'Obel, and on account of its brilliant, though fugitive, flowers, it has maintained its place in gardens ever since.

This species is the only one hitherto known belonging to the true *Tigridia* section of the genus, having large flowers and decurrent stigmas. . . . *T. Pringlei* is a recent discovery made by Mr. C. G. Pringle in the mountains of Chihuahua, much farther to the north than any other species has ever been found. . . . it is very closely related to *T. Pavonia*, and if color alone were to decide, it might be considered a variety of it, though differing markedly even in that respect from the old species. . . . In cultivation at Cambridge [Massachusetts] this season the bulbs commenced to bloom in July and continued to flower for several weeks.

S[ereno] W[atson]

[*Garden and Forest* 1 (1888): 388-389]

*Oceloxochitl*

far away in the soft blue haze [*Garden and Forest* 3 (1890): 337–338].

A short note, "The Home of the Jacobean Lily," shows that not only did Pringle collect and distribute bulbs (without being sure of their identity), but that he sent them as far away as Kew Gardens in London for trial.

It is with some surprise that I hear that bulbs collected last autumn on the foothills of the Cordilleras of western Chihuahua, having flowered at Kew prove to be *Sprekelia formosissima*. So near our borders! The bulbs were found about six inches deep in light brown soil of ledges or rocky hills, dry situations, where the soil of ledges were not crowded upon by many other species. Buried at this depth it is very likely that the bulbs are out of reach of frost. The plants were in leaf throughout the autumn, and grew sometimes even in beds, which at flowering time, probably when the first rains came early in July, must be a brilliant sight [*Garden and Forest* 1 (1888): 309].

While Pringle did occasionally collect live plants for the commercial nursery market, especially *Tigridia* bulbs and orchids, he was primarily a botanical collector. Having seen many of his specimen sheets at the University of Vermont, I can vouch for their being not only of highest quality in terms of mounting and character sets (important identifying floral features), but also tantalizing as potential garden plants. His *Salvia* collections would put to shame the selection currently available in nurseries. *Salvia roeneriana* (#10,160) shows beautiful *Heuchera*-like felted leaves in a basal rosette with a spike of cardinal red flowers. In Iguala Canyon in Guerrero State he found *Salvia muralis* (#10,328) with two-and-a-half-inch flowers of reddish-orange. My favorite is *Salvia sessei* (#8,378), with its huge balloonish bracts of pink, but I would like to propagate them all.

Despite poverty and physical hardship, Pringle continued to work in Mexico even after his trusted assistant Filemon Lozano, in 1909, "reasons with me out of the kindness of his heart, advising me to come no more." Pringle returned for two more short visits, making the last of his 39 expeditions in October 1909. He passed away at the age of 73, on May 25, 1911, after a short bout of pneumonia. A plaque hon-

oring him at the Pringle Herbarium bears a quote from his old mentor, Asa Gray, calling him "the prince of botanical collectors." Again O. W. Barrett:

Doctor Pringle, unlike his rivals in the Mexican field, was wont to "make a clean sweep"—taking specimens of all the species of trees, shrubs, and herbs in each region he "worked," not merely "skimming" the area for likely "cream" of new species. He easily could have gleaned a much greater percentage of new species in the same regions in half the time he did spend; but he conscientiously adhered to his principles, from his deep love and respect for his chosen work—hence the world today has what might be called true Pringle photographic records of Mexican floras instead of incomplete and personally biased sketches of scattered areas. By grouping the Pringle herbarium sheets from a given locality, we have an accurate panorama of the plant population thereof. Probably no other plant collector has ever followed this plan so well over such a vast territory [Davis 1936, 9–11].

Pringle's tens of thousands of dried and pressed specimens give us a portrait not only of an assemblage of plants at a certain place and time, but of the man himself—industrious, enraptured by nature, and above all else, the consummate field botanist.

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Rob Nicholson, who manages the conservatories of the Smith College Botanic Garden, Northampton, Massachusetts, has made several plant-collecting trips to Mexico.

NOTES OF MEXICAN TRAVEL

from THE FOREST VEGETATION OF NORTHERN MEXICO.—II.

POPULUS Fremontii, var. *Wislizeni*, *Watson Cottonwood*. — Though the impression was purposely conveyed . . . that the high plains of North Mexico are destitute of arborescent vegetation, a few unimportant exceptions must be mentioned. Conspicuous among these is this Cottonwood, which rears high its rounded head of abundant bright green foliage, in striking contrast throughout most of the year with the gray and brown tints of the surrounding landscape. This tree is not abundant, because water is not abundant; for it is a sure index of the presence of living water either on the surface of the soil or not far below it. It grows scatteringly along streams or clustered about springs. Its centre of distribution is on the Rio Grande, and it follows this river northward to its upper waters in south Colorado and the Tributaries of this river from whatever direction into their narrower mountain cañons. Westward it ranges along the boundary quite to the Pacific, and southward extensively through the valleys of Mexico, and there often carried by man considerably beyond its indigenous limits.

Cheering to the traveler over heated and dusty hills and plains is the sight of its shining leafage with promise of refreshing shade and water. The Mexicans seem to regard this tree with sentiments similar to those cherished by the Orientals for the Palm or the New Englander for the Maple. They plant it by the water, convenient to which they have built their dwellings, and set it along their irrigating ditches. No visitor to Mexico but has noticed and admired that peculiar feature of Mexican cities, the avenue of grand old Poplars, double-lined on each side it may be, kept alive and flourishing, if on high ground, by streams of water conducted along the rows. The Spanish name for the Cottonwood—for any species of Poplar, in fact—is *Alamo*, that for this avenue *Alameda*, a noun having the form of the perfect participle—that is to say, the Poplared place. . . .

C. G. Pringle

[*Garden and Forest* 1 (1888): 104, 105]



The Alameda of Chihuahua. *Populus Fremontii*. Var.

IN A MEXICAN GARDEN

FOR a few hours of a sunny day in October last I was a guest in an old garden in a village situated by the base of the volcano of Toluca, fully 8,500 feet above the sea; and I found interest in observing what plants are employed by the Mexicans to form a flower-garden and how these succeed at so high an altitude. Light frosts fall in the region, but snows never. The season of growth extends from June to October, a short summer; and the sun during this period is obscured one-third of the time, while the temperature scarcely mounts above eighty degrees, Fahrenheit.

The garden was a quinta, that is, a large garden in the suburbs of a town, devoted usually to flowers, fruits and vegetables, mixed. In the little interior court of their town-house the ladies of the family who entertained, cared for a similar collection of plants, growing in beds in the soil around the central fountain or in great red vases set in a line just under the colonnade surrounding the court—vases of Hydrangeas, Tuberoses, Lilies, Irises, Geraniums, Fuchsias, Roses, etc. The quinta was ampler, an acre or more in extent, and was located by the threshing-floor and granaries of the hacienda, where it joined the village. It was enclosed with a high wall of adobes, more to afford seclusion and security than shelter for the plants. Hither came the family with their friends, whenever they wished to leave their close house for a ramble and an hour in the open air. To serve this use is the design of the quinta. It was laid out with broad walks and borders and was shaded by a few trees. There was the Australian Gum-tree, the furor for which of twenty years ago the Mexicans shared, having been induced to plant it to the exclusion of more beautiful native trees by a German, who had a nursery in the capital city. It succeeds here only too well; there was the Montezuma Pine, Bentham's Cypress, Bonplant's Willow, of erect growth and dark green foliage, the Weeping Willow and the Pepper-tree, with drooping branches quite as graceful as the last and with finer foliage.

Of shrubs I noted *Viburnum Opulus*, *Datura arborea*, a variety with blood-red flowers, the Crape Myrtle, the common *Philadelphus*, *Cassia bicapsularis*, with abundant yellow flowers long maintained; there were great clumps of a double-flowered *Hibiscus* ten feet high, Roses of choicest varieties scattered here and there, with a hedge of them hiding the back wall and overtopping it, Fuchsias in variety, six or eight feet high and woody with age, all blooming throughout most of the year, and Hydrangeas, favorite flowers with the Mexicans. Geraniums with double and with single flowers, and *Pelargoniums* in variety stood, shrub-like, two to five feet high. There were Cactuses leaning against the walls or climbing over them; slender-stemmed species of *Cereus* and thick flat-jointed *Opuntias*, whose flowers are among the most striking, and whose fruits are edible. The tall grass, *Arundo Donax*, which is not uncommon in northern gardens, stood in large old clumps, and there were patches of Ribbon Grass (*Phalaris arundinacea*).

Here, too, were large old masses of *Agapanthus umbellatus*, *Mirabilis multiflora*, *Cal-las*, *Cannas*, *Crinums*, *Tigridias*, *Gladioluses* and *Irises*, all alike thriving in the open soil. Among pretty native flowers, such as species of *Salvia*, *Cuphea* and *Ipomœa*, mingled many flowers whose acquaintance I made in the old-fashioned gardens of my New England home, such as Larkspurs, Marigolds, Pinks, *Chrysanthemums*, the Mullein Pink, the Jerusalem Cherry, the Everlasting Pea, the Bugloss, *Viola odorata*, *V. tricolor*, *Cœnothra biennis*, *Euphorbia*, *Lathyrus*, *Saxifraga crassifolia* and *Vinca major*. To meet with these familiar flowers amid foreign scenes was like falling in with old friends abroad.

Charlotte, Vt.

C. G. Pringle

[*Garden and Forest* 6 (1893): 283]

IN JALISCO (1895)

THE state of Jalisco, by its varied flora, held me closely throughout my ninth season of botanical exploration in the Mexican Republic. I arrived in Guadalajara, its capital, at the beginning of May last, and kept that base until I left the country in the middle of November.

The rains had not commenced when I entered the state, and its plains and hill-sides were brown and dry, as I had never before seen them, for the springs and rills were nearly all dry, and most of the trees and shrubs were still leafless. The few plants gathered during the first two months of my stay were dearly won by diligent gleaning of wide wastes. By the second week of June thunderstorms were advancing, evening by evening, from the southeast over the coast mountains of Michoacan. These soon traversed the entire state, and were seen, if not encountered, each afternoon with unfailing certainty. About the 1st of July all the landscape was covered with unfolding verdure; and from the middle of that month to the middle of October hosts of plants crowded upon the collector wherever he wandered. The last thunder-shower of the season occurred on the 7th of October, and then followed almost cloudless days in long succession. The sunshine was still warm even on the table-lands, and under its influence the soil rapidly dried again, the springs and brooks ceased to flow, and the ripening and passing of the vegetation was as swift as had been its rise and unfolding. On the highlands a few light frosts fell during early November to complete the destruction of the plants and to turn the botanist homeward, unless he chose to glean in the coast regions.

Next to the four great states of the arid regions of the north—Sonora, Chihuahua, Coahuila and Durango—this state of Jalisco is the largest within the Republic. It is certainly the most populous and wealthy of all, and is second to none in fertility of soil. During the six years of my visiting it I have never known its varied harvests to fail in any degree. I have turned from other districts in years when rain failed to visit them, distressed by the sight of the hunger and squalor of their inhabitants, to find the Jaliscenses as well fed and as happy as ever. Lying upon the southern verge of the table-land and bordering the Pacific, this state is within the belt of abundant and unfailing summer rains, and this situation also ensures a climate which is nearly perfect. Its winter frosts are restricted to the higher lands, and even there are few and light. The Andean system, when passing through Jalisco, appears to be depressed or broken up. There are few elevations above 9,000 feet over sea-level, or 3,000 to 4,000 feet above the average of its plains. Here are many extensive plains, valleys and slopes of excellent fertility, and all of these are natural grazing-grounds in summer and winter. Wide fields of Wheat whiten the valleys in spring-time, and yield place to luxuriant crops of Maize in autumn, when the hill-sides up to the very summits are checkered with grain-fields. Toward the coast Cane-fields and Coffee-plantations abound, and in the various conditions offered by this state flourish the fruits of the entire list, tropical and temperate. Yet, notwithstanding so great prosperity, there is forced upon the observer the fact that the capacities of the soil are but half-developed.

Until within a few years Jalisco has lain remote from the activity and progress of the world. Its capital was only reached by a journey of several days by diligence from the city of



"For a hundred miles toward the coast there is a labyrinth of barrancas, whose wildness and grandeur are wonderful . . ."

Mexico, or by long rides in saddle and diligence from the seaports of Manzanillo and San Blas. To-day the tourist is conveyed in a Pullman car over a branch of the Mexican Central, diverging from the main line at Irapuato. A ride thence of only seven or eight hours along the fertile valley of the Lerma brings him to Guadalajara, the proud "Pearl of the West," as the Mexicans style this beautiful city with white-walled palaces and churches and flowery, umbrageous parks, a city second in size only to the national capital. It is situated on an undulating plain at an elevation of 5,000 feet above sea-level. In all directions from the city the view is bounded by hills either of volcanic or of granitic formation, five to ten miles distant, and 1,000 to 2,000 feet higher than the plain. Some of these hills appear of the most rocky and rugged character; others show softer lines, and are covered with a sparse and low forest composed chiefly of *Pinus oöcarpa* and *Quercus fulva*. Twenty-five miles away to the south, beyond several small lakes, rises a chain of mountains some 8,000 feet in altitude, while in the west and north-west, thirty to forty miles distant, appear summits quite as elevated. These higher mountains are clad with forests in which *Pinus Montezumæ*, *Quercus reticulata* and *Q. grisea*, and *Arbutus varians* are the more important species.

Every visitor to Guadalajara must see the great barranca. Passing northward over gravelly swells for five or six miles, one comes to the brink of a river-cut 1,500 feet deep. In the bottom he sees the Lerma, or Santiago, foaming white in its swift descent to the sea. The width of this barranca, from plain to plain, is about a mile. On its sides steep slopes alternate with sheer precipices hundreds of feet in height. The upper slopes are either open and grassy, or are covered with woody growths of numerous species. The lower or more accessible slopes are occupied by plantations of Bananas, Oranges, Mangoes and other tropical fruits; for into this gorge, where are gathered the warm rays of the sun, frosts and mountain breezes cannot descend. A paved trail, two miles in length, leads down to the river by zigzag windings over successive terraces, along the verges or bases of cliffs, and through dark alleys in Banana fields. The banks of the river are shaded by immense wild Figs and Cypresses. Beneath the shade is an Indian village, the huts being of the simplest construction, loose walls of rock surmounted by a thatch of coarse grass. Here, despite the shade, we find ourselves in the oppressive temperature of the tierra caliente. Passengers and freight are ferried across the river in rude canoes, while the beasts of burden are made to swim over. From the farther side of the river the traveler climbs out of the barranca by a trail equally long and difficult. During all the day there is a ceaseless stream of travel crossing this frightful chasm.

As I have descended into this barranca almost daily for weeks of several different seasons, and have searched about its cliffs of various exposures, clambered over its dizzy slopes, or crowded through its thickets, it has seemed that the number of plants which it holds must be inexhaustible. Each year it has yielded new species. Yet this is but the first and uppermost of the barrancas of the Santiago and its tributaries. For a hundred miles toward the coast there is a labyrinth of barrancas, whose wildness and grandeur are wonderful, and similar barranca systems have been formed by every stream which flows down from the table-lands.

During five seasons I had sojourned in Guadalajara for a few days or a few weeks at a time in different months of the year to work the surrounding country, its hills and plains, as well as its barrancas, and had taken out many hundreds of species; so my return last May was only to secure for general distribution certain new or rare species known to me, and to make one or two trips toward the sea before moving to a distant and fresh field. But while this object was being accomplished, so many plants offered themselves to my hand which were strange to me and promised novelty, that I kept to this field until the end of the season, and then brought out a richer harvest than ever before . . .

C. G. Pringle

The Shapes of Trees: A Matter of Compromise

Peter Thomas

The whole point of a tree's woody skeleton is to ensure that the leaves get as much light as possible. At the same time, the tree must attend to its needs for pollination and seed dispersal and cope with environmental challenges like high winds and poor soil—all the while investing as efficiently as possible in its woody structure. The enormous range of tree shapes that we see—from the unbranched stems of palms and tree ferns to the tall spires of conifers, the oaks' broad, spreading crowns, and the multiple stems of old yews—all represent compromises among these often conflicting goals.

The nature of the compromise can be hard to pinpoint, but some gross generalizations are possible. Tree shapes can be divided simplistically into two categories: the conical outline of conifers and the rounded dome of hardwoods. Conifers of high latitude and altitude are typically steeply pyramidal with short branches that slope downwards to help shed snow and to intercept the maximum amount of light from a sun that is low on the horizon. The very similar shape found on conifers in dry regions, by contrast, appears to be an adaptation for intercepting the *least* amount of light (and therefore the least heat) when the sun is at its noonday hottest, thereby reducing the amount of water loss needed for cooling.

Pines farther south in savanna-type climates, such as the Mediterranean stone pine (*Pinus pinea*), develop a flat-topped, umbrella shape that helps resist drying winds by allowing leaves to hide behind one another and at the same time maximizes heat loss by allowing free passage of air up through the canopy.

The broad crowns of most hardwoods, on the other hand, are associated with cloudy climates,



Sitka spruce (Picea sitchensis) with the typical spire of conifers with whorls of short branches. Perthshire, Scotland.

where the light is diffused and in effect comes from over the whole sky—the environment of most of Great Britain and the Pacific coast of North America, where most trees take on the same roughly spherical shape.

The Biomechanics of Shapes

The principles of biomechanics play a large part in determining the sorts of compromises that trees must make. The longer a branch, the more



Stone pine (*Pinus pinea*) growing in Tuscany, Italy, showing the aerofoil shape of the canopy, which helps in conserving water.



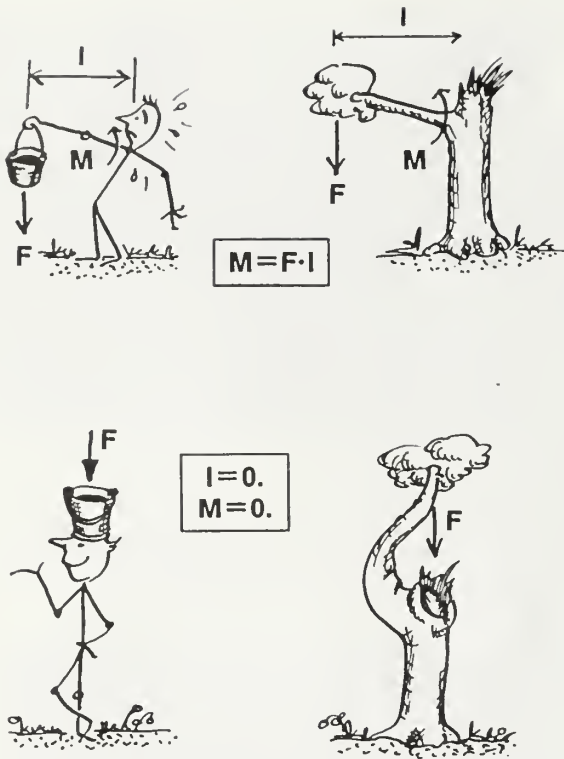
The distinctive shape of european linden (*Tilia x europaea*). At left, note the typical arching curves of the main branches. Because the end buds tend to die, new growth comes from near the branch end, resulting in another arch, creating the effect of multiple rainbows joined together at their ends.

The tree at right has the characteristic congested growth of small twigs in the center of the canopy. What you can't see are the mass of shoots that normally spring from the base of the tree. Staffordshire, England.



Branches of two english oaks (*Quercus robur*) grafted together. Just as roots pressing against each other will weld together, so will branches. This is often claimed to be impossible because the constant movement by wind prevents the tissues joining, but with enough pressure the union is possible, as demonstrated by the photograph. Cheshire, England.





After the loss of the top part of the tree, a single branch acts like a lever, bending the stem where the twisting force exerted (M) is the weight of the branch (F) multiplied by the length of the lever (l , branch base to the branch's center of gravity). The tree reacts by bending the branch to reduce the length of the lever (the twisting force becomes zero), thus bringing the center of gravity of the branch over the base of the trunk. This is analogous to the ease with which we can carry a bucket of water.

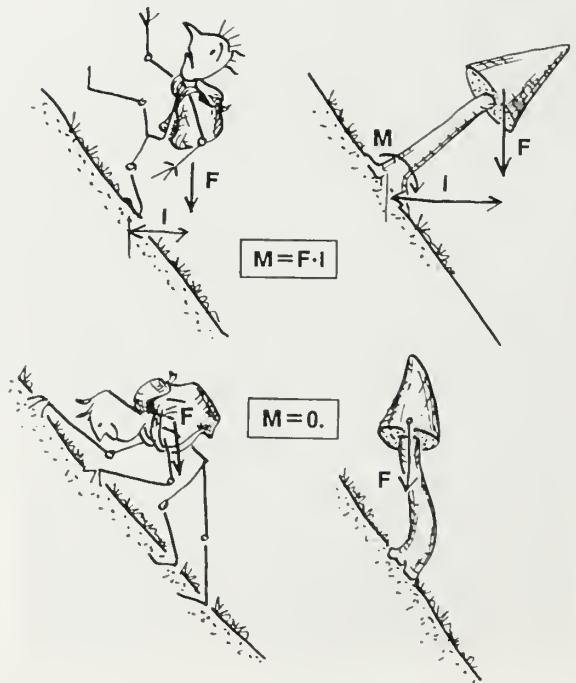
likely it is to break under the pull of gravity, in the same way that a longer wrench puts more turning force on a stiff nut. The tree must therefore compromise between displaying as many leaves as possible and limiting the growth of the branch to a manageable length. There are ways of cheating, of course. If branches graft together, the additional support can allow them to become abnormally long without breaking. But trees also try to balance their weight on all sides, with no net force acting to bend the trunk. The drawing above shows a tree that has lost its top, leaving one branch sticking out sideways. To reduce the strain on the trunk imposed by this lopsidedness, the branch will soon begin to bend upright even if the tree is in the open and gets no additional light by doing so.

The same principle applies when entire trees lean. The leaning tree shown in the drawing below will gradually bend to bring its center of gravity above its base, thereby reducing the danger of falling over. We do the same thing when carrying a heavy load on our backs, bending forward to get the center of gravity above our feet. Here again, however, the tree may need to compromise between conflicting goals: in order to reach extra light, it may undergo the strain of unbalanced weight by leaning out into the center of a gap in the forest.

Buds, Branches, and Tree Shapes

How do trees manage to grow into their characteristic shapes? The question is best answered by examining the building blocks used. While animals basically have a fixed shape that simply gets bigger as they grow to adulthood, plants grow by repeatedly adding small modules.

The basic module of a tree is the portion of a twig that it grows each year from the terminal bud at the end of the previous year's growth.



A leaning tree will straighten to reduce the twisting force exerted by gravity, in the same way that we bend forward when carrying a heavy pack to bring the center of gravity over our feet.

It is obvious, of course, that the shape of an individual tree will vary with conditions. Light, wind, snow, herbivory, fire, root health, and many other factors can influence shape. For example, in an effort to reach more light, species that form a bushy crown when grown in the open may take a taller and narrower form with fewer side branches when grown in the shade. Mountains provide ample evidence of the effect the environment has on the shapes of individual trees. Because of increased wind, conifers become shorter and squatter the higher they grow on a mountain. Quite literally, shaking, or even rubbing, a tree stunts its growth: a greenhouse study showed that shaking sweetgum trees (*Liquidambar styraciflua*) for just thirty seconds a day reduced their vertical growth to less than a third that of the unshaken trees.* This makes good mechanical sense: the stronger the wind the more leverage is exerted on the tree so its optimum design will be squatter.

Higher up on a mountain, trees survive only in tight, isolated clumps usually called Krummholz (German for "crooked wood"). In winter, harsh winds carrying ice particles wear away the waxy coating on needles, leaving them open to death by dehydration. This often produces "banner" trees that look like flags blowing in the wind, with branches surviving only in the lee of the prevailing wind. Flagging can also be seen on cliffs by the sea, where the effect of wind is exacerbated not by ice but by salt spray.

But trees are not passive in the face of the environment: they react. If branches are lost, new ones can be grown from stored buds or from



PETER THOMAS

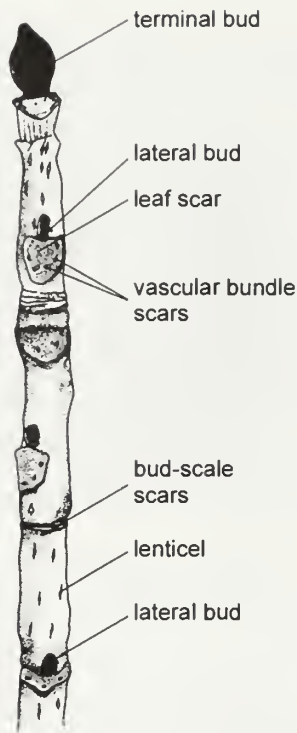


PETER THOMAS

Subalpine fir (Abies lasiocarpa) in the Canadian Rocky Mountains demonstrating the effect of hostile conditions at high altitude. Above, a "flagged" specimen, bare on the side facing prevailing winds. Below, a larger clump of Krummholz with the prevailing winds moving into the picture. Note the skirt of healthy foliage around the bottom, showing where snow protects against winter winds.

new adventitious buds. Or an existing branch can fill the gap, perhaps by bending or taking on a different role. This is seen to perfection when a tree falls over but remains at least partly rooted. What were minor side branches become the new leaders, eventually producing a row of what appear to be individual trees.

* Neel and Harris 1971



A branch in winter. The successive sets of bud scale scars mark how much of the branch grew each year. The leaf scars mark the positions of the previous year's leaves and the bud associated with each leaf can be seen clearly.

The young twig bears a number of leaves that leave behind a scar to mark the year's growth when they fall off, as well as a lateral (or axillary) bud that contains next year's growth—a new twig complete with leaves and new buds. New leaves can only be grown on new twigs, although the twig is sometimes inconspicuous. Each new module, or new addition to a twig, is the fingerlike projection of the new coat of wood that is added every year over the entire tree, so last year's twig will be fatter this year and will have two rings. The twig from the year before will be fatter still and will have three rings, and so on, the branch getting thicker as you trace back to the trunk.

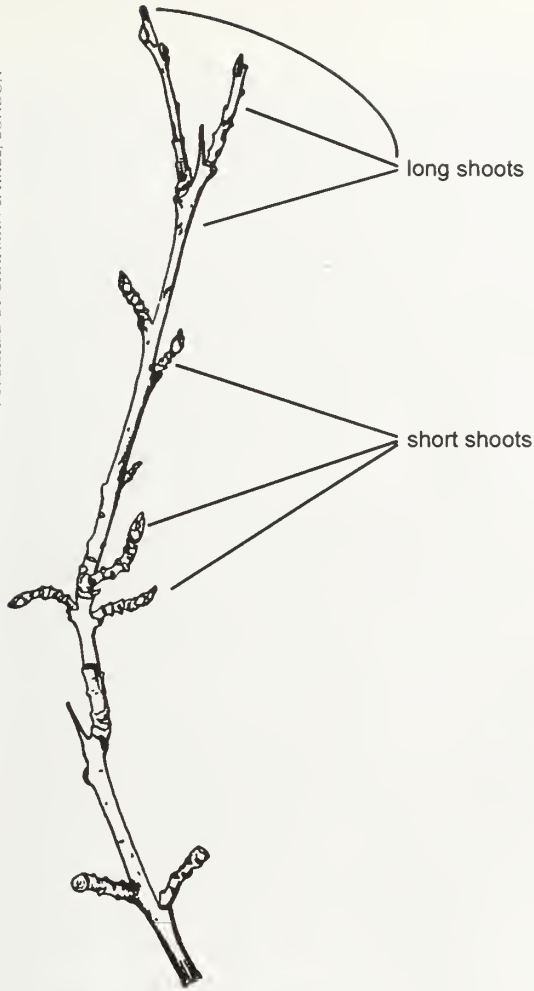
But if every bud on a tree grew into a branch, the canopy would soon become a hopeless tangle, and a hundred-year-old oak would have ninety-nine orders of branching, whereas in reality temperate trees rarely show more than

five to eight orders and tropical trees have at most four. (Tropical trees generally have bigger leaves, requiring a less dense network of branches to hold them.) A tree has three major strategies for limiting the number of branches: getting rid of its excess buds, shedding branches, and altering the length of branches.

Environmental conditions sometimes help the tree get rid of excess buds. Spring frosts may kill them, or neighboring trees or branches may rub against them in the wind, causing them to fall off. But trees have methods for solving the problem of excess buds themselves. European white birch (*Betula pendula*)—and undoubtedly other trees—develops fewer buds in parts of the crown that are already dense, or where the crowns of different trees meet. In shaded parts of trees many buds die, which explains the tendency of trees in close proximity to grow more on the sides that face away from neighbors. In some species, such as oaks, surplus buds are deliberately aborted. In fact, there is a steady rain of aborted buds from oak canopies throughout the growing season, representing as much as 45 to 70 percent of all buds produced. Or the buds may be "stored" unopened for future years.

In addition, some buds simply fail to develop as a normal part of the tree's lifecycle. The spines of hawthorn and honey locust and the bundles of needles on pines are all modified branches that eventually lose the ability to produce new buds. Conifers with many small, needlelike leaves, like spruces and firs, concentrate resources in relatively few buds at the end of each year's branches; if they produced a bud in the axil of every leaf, they would end up with an impossible number of buds and potential branches.

Trees can also avoid clogged canopies by getting rid of branches once they have achieved their purpose. As a tree gets bigger, it continues to grow new layers of foliage. If you look up through the canopy of a large tree, you will see that its center is made up of large branches (the "scaffold branches"), with small branches only at the edge of the canopy; those that once occupied the shaded center (the "dysphotic zone") are long gone. In many trees, branch shedding is a regular, seasonal act, just like leaf



A shoot of purging buckthorn (Rhamnus catharticus) made up of long shoots and short shoots.

shedding in autumn. Some species regularly shed small twigs complete with leaves toward the end of summer; others shed only the twigs that do not produce enough carbohydrate to cover their own running costs, perhaps because of inadequate light.

A less drastic way for trees to avoid congestion in the canopy is to regulate branch length. In many trees there is a clear distinction between “long” and “short” branches, or shoots. This is true of apple, birch, beech, hornbeam, katsura, ginkgo, pines, larches, and cedars, and to a lesser extent of elm, poplar, and linden. The long branches form the framework of the tree, making it bigger. The job of the short branches (called “spur shoots”) is to produce leaves, and

often flowers, at more or less the same position every year. They can be distinguished by the proximity of their annual bud scales, since they grow in length each year only enough to produce closely packed leaves and the next set of buds. The bundles of needles on pines, cedars, and larches are also borne on short shoots.

Flowers and Tree Shapes

Flowering is an important determinant of tree shape because the shoot that produces a flower dies when flowering and fruiting end and consequently does not produce a new bud. In magnolias, dogwoods, maples, and horse chestnuts, the flowering tip is replaced in the next year by two side buds, leaving a fork to mark where the flowers were. In elms and cherries, on the other hand, the terminal bud of each twig, and perhaps of one or more farther back, produces only leaves, while the buds still farther back on the twig produce only flowers. More complicated patterns exist in which trees produce mixed buds containing both flowers and leaves (plums, pears, blackcurrant). In all cases, however, it is clear that different patterns of flowering produce different patterns of branching, thereby affecting the overall shape of the tree.

How Does the Tree Control Shape?

We have seen that the shape of a tree is governed by the way buds and branches grow and die. How does the tree control this? In the simplest terms, the end, or apex, of each branch governs what happens farther back along the branch, or lower down in the tree, in a process influenced by the amount of available light: the more light it gets, the more power an apex has. The top-most growing tip—the leader—has the most power of all. In turn, the strongly growing ends of side branches have great influence over the buds and smaller branches near them, but they themselves are still influenced by the leader. In effect, every growing tip from the very top apex to the most insignificant branch end exerts some control, albeit greatly varying in importance. The more minor the bud, the more likely it is to be suppressed or to result in a small, slow-growing branch. Complete removal of the leader or of another powerful branch by pruning



Cherry (*Prunus*). Terminal buds, and the next one farther back on the end shoot, have produced just leaves (marked a and b respectively). Buds farther back along the twig have produced just flowers.

or by accidental damage means that one or more lesser branches—or a completely new branch from a previously suppressed bud—will bend upwards and compete to be the new leader. This is the reason that clipping young Christmas trees results in bushier trees.

Two terms are used to describe this hierarchical control. *Apical dominance* refers to the ability to prevent buds from developing in the first place and is the force leading to the rounded ovals of hardwoods. *Apical control* refers to the ability to govern the growth from nonsuppressed buds and is responsible for the spire shapes of conifers. In rounded trees with high apical dominance, like the oak, lateral buds are often suppressed until they are left so far behind the terminal end of the branch that they are finally able to develop into branches themselves, and the spire shape of the young tree gradually disappears into a rounded mass of strong branches.

Conversely, in conifers with weak apical dominance, most of the buds are allowed to grow, but because of strong apical control, the leader keeps the new branches shorter and more horizontal. Because the older branches lower down continue to grow, the conifer's spire shape is maintained throughout the life of the tree.

The mechanism by which bud growth is regulated is not perfectly understood. It is known that the hormone auxin, and perhaps other hormones such as cytokinins, play a fundamental role. Auxin is produced at the apices and is transported through the phloem. Internal competition for minerals and sugars no doubt also plays a part. A number of studies have shown that "shoot inversion"—bending the upper shoot over to point downwards—can weaken apical regulation. This undoubtedly explains the old country custom in Great Britain of snapping over the top branches of hazel trees to improve fruiting: hazelnuts are borne on short shoots, which will grow and fruit more prolifically once apical regulation is partly removed. It also explains how true weeping trees grow taller: as the leader gets longer and flops over, it loses apical dominance and releases lateral buds to produce new branches that grow upwards and eventually flop over in turn.

Changes with Age

Because of the modular growth patterns of trees, a mature tree is not just a seedling writ large; its shape changes with age. The branching in young trees is usually much less dense than in older trees, especially in species with compound leaves (which in effect are cheap, throwaway branches, as in horse chestnut), or that self-prune (as do tulip trees [*Liriodendron tulipifera*], easily identified by their long straight, unbranched trunks). Tropical trees, which can sometimes be aged purely by their shape, may reach 25 feet in height before branching. The speed with which the shape changes depends on the species (early in horse chestnuts, late in poplars, never in many conifers) and on the soil (earlier on drier, poor soils).

Branch angles also change with age. Over the short term, branches have a set angle to which they try to return if bent, by the weight of snow, for instance. But over the long term, branches tend to sag as they get longer and heavier, a change that intensifies as more new wood is added to the crotch—just as putting on more and more coats forces a person's arms to be more and more horizontal. Thus younger branches at the top of the tree are the most upright, while the increasingly older branches farther down become more and more horizontal.

One may think of the sagging of old branches as one of the disadvantages of age, like wrinkles and an expanding waistline, but in fact trees may benefit from these changes. The erect shape of a young tree encourages rainfall to run down the trunk, concentrating it on the developing roots at the base. In an older tree, however, the sagging branches and weeping tips encourage most of the water to drip off the edge of the canopy onto the area where it is most needed—above the absorbent ends of the tree's growing roots.

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Peter Thomas is a lecturer in environmental science at Keele University, United Kingdom, where he teaches tree ecology, tree design and biomechanics, wood structure, and woodland management. This article was adapted from his book *Trees: Their Natural History*, published in 2000 and reprinted with the permission of Cambridge University Press.

Designing Woman: Martha Brookes Hutcheson

Rebecca Warren Davidson

A number of America's first women landscape architects depended on informal learning at the Arnold Arboretum as part of their professional training, and Martha Brookes Hutcheson (1871–1959) was among the most talented of them. Two examples of her work in Massachusetts gardens are now open to the public—Maudslay State Park in Newburyport and the Longfellow National Historic Site in Cambridge—as well as a third, her own home in Gladstone, New Jersey, now Bamboo Brook Outdoor Education Center. Even as the Longfellow Site is being restored, the Library of American Landscape History has reprinted Hutcheson's widely praised articulation of the architectural principles of garden design, *The Spirit of the Garden*. The following essay on her training and practice is excerpted from the introduction to the new edition.

When Martha Brookes Hutcheson's *The Spirit of the Garden* appeared in 1923, the number of books already available brimming with advice for the amateur gardener might have daunted a less assured writer.¹ As Hutcheson observed in her foreword, there already existed a proliferation of literature that provided "comprehensive and helpful planting-charts, color-schemes and lists of valuable varieties of plants"—information, in other words, to enable the amateur to create interesting and attractive set pieces of garden art. Hutcheson, however, was confident that her book would find a place on the shelves of many newly prosperous, upwardly mobile Americans who were avidly seeking advice on homebuilding, decorating, and especially gardening. Her contribution offered something unique: a straightforward articulation of the basic architectural principles of the design of space and their application in the small garden, combined with an enthusias-

tic and knowledgeable advocacy of the use of native plants.

History has proved Hutcheson correct. Although she maintained that her book was neither a practical manual of instruction on how to make a garden nor a substitute for employing the services of a professional landscape designer, nevertheless it clearly filled such a need, particularly for the many Americans in the 1920s who were becoming homeowners for the first time. And *The Spirit of the Garden* continues to be read and valued, not only for its clear explanation of landscape design concepts but also for Hutcheson's ideas on the social and cultural importance of gardens to individuals and to their communities.





Detail of the pergola in the rose garden at Maudesleigh, as it appeared in the 1920s. The Newburyport, Massachusetts, estate, which was designed by Martha Brookes Hutcheson for Frederick S. Moseley, is now open to the public as Maudslay State Park. Photograph by Martha Brookes Hutcheson, courtesy of the Morris County Commission, New Jersey.

That Hutcheson is little known today has to do in part with the fact that Hutcheson's active career lasted a short time: her first documented work dates from 1901, and she seems to have built little after her marriage in 1910. Another contributing factor is that her work, almost without exception, consisted of private, domestic gardens for wealthy Northeasterners. The design of large-scale landscape projects was the nearly exclusive purview of men in early

twentieth-century America, and their built works—urban parks, cemeteries, parkways, and subdivisions—have also, quite naturally, been the focus of most previous historical research.² The smaller, domestic garden in the United States was generally left to the care of women, and the work of those who

did create successful careers for themselves as designers, photographers, and writers focusing on these small private spaces has been marginalized because of its perceived lack of social relevance as well as its association with “women's work.”

Martha Brookes Brown Hutcheson was born in New York City on 2 October 1871. She grew up in a family of avid gardeners, and as an adult she

recalled among her earliest pleasurable experiences working in the gardens and fields of her great-uncle John Pomeroy's farm, Fern Hill, near Burlington, Vermont, where her family spent every summer.³ From 1893 to 1895 she attended the New York School of Applied Design for Women. Like many other young people of the day with the means to do so, she augmented her formal education by undertaking the American equivalent of the grand tour, studying and making notes on gardens in England, France, and Italy during the late 1890s.

In 1900 the country's first academic programs in landscape architecture were instituted, at Harvard (restricted to male applicants only⁴) and at the Massachusetts Institute of Technology. Hutcheson enrolled at MIT where, although official policy did not exclude women, they found gaining admission difficult because of their lack of opportunity to study the mathematics and sciences that were vital parts of the entrance requirements and the curriculum. Undoubtedly Hutcheson's family expected her to marry or perhaps pursue a career in the decorative arts, but Hutcheson had other ideas, as she later recalled:

About 1898, one day I saw the grounds of Bellevue Hospital in New York, on which nothing was planted, and was overcome with the terrible waste of opportunity for beauty which was not being given to the hundreds of patients who could see it or go to it, in convalescence. In trying to find out how I could get in touch with such authorities as those who might allow me to plant the area of ground, I stumbled upon the fact that my aim would be politically impossible, but that there was a course in Landscape Architecture being formed at the Massachusetts Institute of Technology, the first course which America had ever held. After a conference with those in connection with this training, and with Mrs. Farrand, who was then practicing alone in the field, I was fired with the desire to enter the Institute . . . [and] I began at once to study the mathematics which were required for entrance, and to put my private-school-tutored mind into as good shape as I could on the various subjects before entering the second year of the course.⁵

MIT's program strongly emphasized the architectural and scientific aspects of landscape design, with courses such as perspective and



Charcoal sketch of Martha Brookes Hutcheson by Jane de Glehn, 1922.

topographical drawing, geometry, physics, and structural geology composing a major portion of the curriculum. Only in the second term of the fourth (and final) year was any requirement listed that focused on the social importance of landscape architecture: a course in public health and sanitation.⁶ Although horticulture was offered in each term of the second, third, and fourth years, Hutcheson found MIT's program inadequate in this respect, and later wrote, "I saw at once that the curriculum did not give nearly enough time to what must be known of the plant world." Accordingly, she took the course of lectures offered by Professor Watson at Harvard University's Bussey Institution and made further studies at local commercial nurseries to "note periods of bloom, combinations in color, variety of species in flowers, and the effects of perennials after blooming."⁷

Hutcheson left MIT in 1902 without taking a degree and opened her own office in Boston that

same year. *The Spirit of the Garden*, published twenty-one years later, showcases—with Hutcheson's own photographs—the best of the more than fifty private gardens she designed and built during the career that ensued and summarizes the skill and knowledge accumulated over the course of her professional life.⁸

The fundamental tenet of her design philosophy, namely, to combine elements of European (and more specifically Italian) design—axes, vistas, and an architectural framework—with the richness and variety of native plant material and a freer planting style, is alluded to in her foreword. “As individuals,” she writes, “we are slowly becoming conscious of the value of cul-

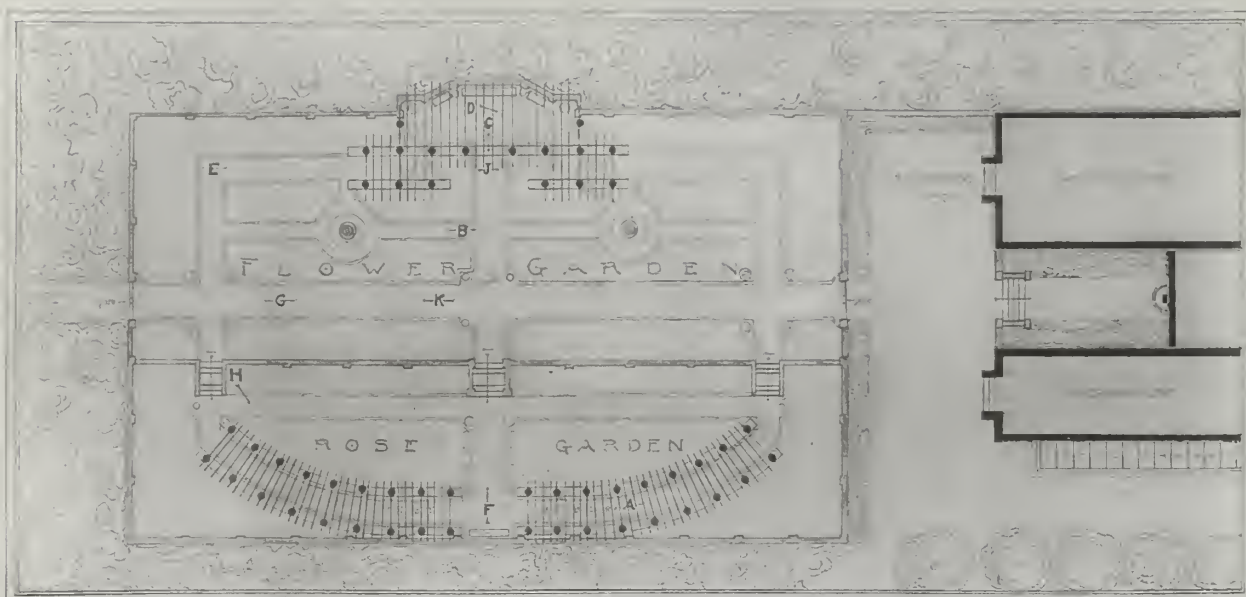
tivated and aesthetic knowledge in adapting to our home surroundings the good principles in planning which have been handed down to us from the Old World.”⁹ To this emphasis on the importance of studying historical precedent and reshaping the best of this legacy in contemporary gardens, Hutcheson added three guiding principles: the necessity of a strong relationship between house and garden; the idea of the garden as an “outdoor room” whose hedges, walls, and paths blend the disparate elements of the garden into a harmonious whole; and the use of less structured plantings in more informal areas to blend the garden naturally with the surrounding landscape.

The Spirit of the Garden includes three of Hutcheson's own site plans of gardens to illustrate how it might be possible to create a system of logical relationships among house, garden, and surrounding landscape. These relationships not only would “tie everything together” but would also provide what she memorably termed the “reasonable complexity of a garden”¹⁰—in other words, the variety and interest that can result from revealing controlled vistas or glimpses from one part of the garden into another, making the farther rooms or reaches seem mysterious and inviting.

She believed, for example, that the designer should always include some changes in ground level—even if slight and unobtrusive—both within the garden and between the garden and its surroundings. Well-orchestrated changes in level can be used to give a sense of intimacy to certain chosen spaces, providing contrast and surprise to a walk through the garden. Terrac-



Martha Brookes Hutcheson actively promoted many landscape-related progressive causes. She was one of the founders of the Woman's Land Army of America, which attempted to alleviate the shortage of farm labor during World War I by employing women. Seen here are members of the Women's Land Army at her summer home. Today Merchiston Farm is in the care of the Morris County Park Commission as Bamboo Brook Outdoor Education Center. It offers an excellent opportunity to experience Hutcheson's built work and to understand her design intentions in three-dimensional form.



Plan of gardens at Maudesleigh, ca. 1902, drawn by Hutcheson. Her photograph of the formal flower garden, seen on the inside front cover, corresponds to D on the plan.



"Roses," sketch made while Martha Brookes Brown was a student at the New York School of Applied Design for Women, ca. 1895. A number of her original sketches and finished designs are preserved in her former home, Merchiston Farm, near Gladstone, New Jersey, now administered as the Bamboo Brook Outdoor Education Center by the Morris County Park Commission, to whom the property and Hutcheson's papers were bequeathed by her daughter and son-in-law in 1972.

ing, steps, and pathways can be understood not only as tools for solving the practical problems of getting from one space to another; they also help set the garden apart from both architecture and nature as a distinct and fortunate place. Indeed, the separation of the garden from its surroundings, as "a place apart," was as important to Hutcheson as the connections with them.

What she calls the "green elements" of a garden—trees, shrubs, and hedges—are given their own chapter in the book [see reprint following this article]. They are also, of course, basic structural elements, and here Hutcheson's knowledge and experience of Italian gardens provided her with particularly instructive examples. The hedges at the Boboli Gardens in Florence and the Villa d'Este at Tivoli—to mention just two of the best examples—are chosen to illustrate how "the green used . . . in the construction of gardens gives us our backgrounds, our contrasts, our proportions, our perspective—above all, our shadows." Hutcheson believed that flowers had been overemphasized in American gardens at the expense of basic structure and form, leading to "too solid a mass of color and too little well-planned green."¹¹

Her photographs and discussion of Maudesleigh prove the effectiveness of her approach. At Maudesleigh, the estate of Frederick S. Moseley in Newburyport, Massachusetts, Hutcheson created a number of gardens, redesigned the approach drive to the house, and made various other changes to the landscape over a period of some twenty years.



Hutcheson's work at the Craigie-Longfellow House in Cambridge, Massachusetts, which she herself called a "restoration," is included in the garden restoration now in progress at what is now the Craigie-Longfellow National Historic Site.



A gateway and border in the flower garden at Maudesleigh.

Because of its size and visibility within the community of wealthy New England garden builders, Maudesleigh was a tremendously important commission for Hutcheson. It is also significant as one of the few remaining Hutcheson designs



Gates along an axis in Maudesleigh's flower garden.

in any degree intact today and open to the public. Although the house is no longer extant, the drives and gardens she designed for it are now part of Maudslay State Park.

Hutcheson faced a difficult challenge at Maudesleigh. Both the site of the house and the location of the new garden (with no obvious or coherent relationship to each other) had already been determined by the client.¹² These constraints not only made it impossible to join the garden directly with the house, they necessitated a major project to screen the view of the greenhouses and a water tower north of the garden. Hutcheson's solution was to design a long, curving path from the entrance to the house, which straightened as it approached and again as it left the garden, providing the illusion of axial connection but also an aura of mystery and surprise as it eventually led to "a natural wooded walk of great beauty beyond."¹³ Having achieved this atmosphere, Hutcheson created an enclosed garden—analogue to the Italian *giardino segreto*—filled with roses, perennials, arbors, fountain, sundial, and birdbath, and surrounded by a hedge to hide the greenhouses and promote a general feeling of peace and seclusion. Substantial plantings of native shrubs and

trees were also made on the formerly bare hillside between the garden and the unfortunately prominent water tower.

The resulting changes in view from the formal garden to the greenhouse are dramatically illustrated in photographs that show how the original bare site was transformed into a sheltered space whose arbors and luxuriant plantings almost totally obscured any intrusion from the outside world, except through the arched openings cut in the hedge for paths. Hutcheson's other major achievement at Maudesleigh also affected the relationships among house, gardens, and landscape. She persuaded her client to relocate the main approach drive from the side

of the house that faced the Merrimack River to the opposite "land" side, thereby separating the views of the architecture from the most dramatic views of the river, to the advantage of each.

Maudesleigh is just one of the many specific examples included in the narrative and illustrations of *The Spirit of the Garden* to show how the general principles that Martha Brookes Hutcheson defined were to be carried out. Regrettably little physical evidence remains, but it is clear from the pictures and written record that she was a skillful gardenmaker and—perhaps of even more significance—an articulate and influential advocate for good design. Her most important contribution arguably was her understandable articulation of a set of architectural, rational principles of design, expressed both in the gardens she created and in her writings. These principles—the ideal unity of house, garden, and landscape; the garden as an outdoor room, with a structure of walls, hedges, paths, and ornamentation that could be the focus of a logical planning scheme; and the integration of both formal and informal elements, often through the use of naturalized

MARTHA BROOKES BROWN HUTCHESON

KNOWN GARDEN COMMISSIONS, CONSULTATIONS, AND EXECUTED WORK 1901-1934

CONNECTICUT

Stonington
Miss Mary E. Dreier

MASSACHUSETTS

Beverly
Mr. Robert Hooper
Boston
Mr. Charles C. Walker
Brookline
Miss Elizabeth Head
Cambridge
Miss Alice Longfellow, "Craigie House"
(now Craigie-Longfellow National Historic Site)
Mr. Edward C. Moore
Danvers
Mr. Francis Peabody
Dover
Mr. Arthur E. Davis
Gloucester
Miss Myra Tutt, "Eastern Point"
Hamilton
Mr. A. Lithgow Devens
Ipswich
Appleton
Mr. Eugene A. Crockett
Mr. Robert G. Dodge
Lancaster
Mr. Eugene Thayer
Manchester
Mr. Charles Head, "Undercliff"
Mr. Francis M. Whitehouse, "Crowhurst"
Newburyport
Mr. Frederick S. Moseley, "Maudesleigh"
(now Maudslay State Park)
North Beverly
Mr. John Philips
Petersham
Simes
Prides Crossing
Mr. Charles Head
Mrs. Oliver Ames, "Highwall"
Readville
Amory
Wareham
Mr. Stephen M. Weld, "Indian Neck"
Wellesley
Mr. Walter Hunnewell
West Manchester
Mr. Robert C. Hooper
Yarmouth
Mr. Gorham Bacon
Unknown city in Massachusetts
Miss M. Pierce

NEW JERSEY

Gladstone
Mr. William A. Hutcheson, "Merchiston Farm"
(now Bamboo Brook Outdoor Education Center,
Morris County Park Commission)
Mr. John Sloane
Morristown
Fraser
New Vernon
Mr. Thomas M. Debevoise
Princeton
Dr. Stewart Paton

Red Bank

Mr. Andrew V. Stout, "Brick House"
Mr. Herbert N. Straus

NEW YORK

Bedford Hills
Mr. William Borland
Mrs. Henry Marquand, "Whitegates Farm"
Brookville
Mr. David Dows
Glen Cove
Mr. Frederick B. Pratt, "Poplar Hill"
Mrs. Harold I. Pratt, "Welwyn"
Great River
Mr. Julien T. Davies
Lawrence
Mrs. Daniel Lord, "Sosiego"
Mr. Hobart Porter
Manhasset
Mr. Payne Whitney
Millbrook
Mrs. Oakleigh Thorne
Mt. Kisco
Mr. Reginald H. Bishop
Mr. Louis Boissevain
Mr. Carl Petrasch
Oyster Bay
Mrs. Charles Tiffany
Plandome
Mr. W. B. Leeds
Suffern
Dr. Henry Patterson
Westbury
Mrs. Robert Bacon, "Oldfields"
Westport
Mr. Charles Head, "Headlands"

OHIO

College Hill
Mr. Peter G. Thomson

PENNSYLVANIA

Bryn Mawr
Mrs. Charles Tiffany
Sewickley
Mr. J. H. Tate
Shields
Mr. J. G. Pontefract

RHODE ISLAND

Newport
Miss Susan Travers

VERMONT

Bennington
Bennington College
Mrs. James A. Eddy
Mr. Howard H. Shields
Putney
Andrews
Woodstock
Miss Elizabeth Billings (now Marsh-Billings-
Rockefeller National Historic Site)

UNKNOWN LOCATION

Mr. Everett V. Macy
Mr. Frederick Peterson

plantings within an architectural framework—still inform domestic gardenmaking in the United States today. Although many of her basic ideas were derived from Italian and English traditions, Hutcheson's advocacy of native scenery and her use of local plant materials made her gardens distinctly "American" and helped foster an appreciation for what, even in the early twentieth century, was a rapidly vanishing landscape.

Endnotes

¹ Some idea of the amount and variety of this literature may be glimpsed in Anna Gilman Hill, "The Gardener's Miscellany: The Literature of American Gardening," *Garden Club of America Bulletin*, ns., no. 20 (November 1924): 47–53, and in Stephen F. Hamblin, "Gardening Books for the Client," *Landscape Architecture* 10 (April 1920): 122–123. Hill actually mentions Hutcheson, on p. 53, along with Fletcher Steele and Grace Tabor, as the authors she finds most helpful on the subject of design. See also Elisabeth Washburn, "Addendum of Books Published from 1861–1920," in U. P. Hedrick, *A History of Horticulture in America*, rev. ed. (Portland, OR: Timber Press, 1988): 557–566; and Beverly Seaton, "Gardening Books for the Commuter's Wife, 1900–1937," *Landscape* 28, no. 2 (1985): 41–47.

² Some exceptions are Beatrix Farrand's work on the campuses of Princeton and Yale, Ellen Shipman's design for Lake Shore Drive in Grosse Pointe, Michigan, and Marjorie Sewell Cautley's landscaping for such planned developments as Sunnyside Gardens, New York, and Radburn, New Jersey.

³ Biographical information has been compiled from American Society of Landscape Architects membership application forms, letters, and other documents held in the Martha Brookes Hutcheson Archives, currently in the care of the Morris County Park Commission, Morristown, New Jersey; hereafter cited as MBHA. Hutcheson herself supplied brief biographical data for Clarence Fowler's "Three Women in Landscape Architecture [Beatrix Jones Farrand, Martha Brookes Hutcheson, Marian Cruger Coffin]," *Cambridge School of Domestic and Landscape Architecture Alumnae Bulletin* 4 (April 1932): 7–12. Fuller discussions of Hutcheson's life and work are in Rebecca Warren Davidson, "Images and Ideas of the Italian Garden in American Landscape Architecture" (Ph.D. diss., Cornell University, 1994), esp. 322–378; idem, "The Spirit of the American Garden: Landscape and Cultural Expression in the Work of Martha Brookes Hutcheson," *Journal of the New England Garden History Society* 4 (Spring 1996): 22–29.

⁴ Only under wartime duress in 1942 did Harvard open its doors to women.

⁵ Hutcheson, quoted in Fowler, "Three Women," 9.

⁶ "Option 3. Landscape Architecture," Massachusetts Institute of Technology, Boston, Department of Architecture [course catalog] (Boston, 1901), 75.

⁷ Hutcheson, quoted in Fowler, "Three Women," 10.

⁸ In her application for membership in the American Society of Landscape Architects (ASLA), dated 3 March 1920, Hutcheson stated that during the time she was head of her own office in Boston and New York (1901–1910), "some 83 private places or gardens were laid out from my plans under my supervision." Her "Professional Record," however, lists only 48 clients. Undoubtedly, more gardens designed by Hutcheson remain to be discovered. ASLA applications and typescript "Professional Record" are among the papers held in MBHA.

⁹ Martha Brookes Hutcheson, *The Spirit of the Garden* (Boston: Atlantic Monthly Press, 1923). For a more extensive discussion of Hutcheson's contribution in this regard, and the importance of the Italian model in American landscape design, see Davidson, "Images and Ideas."

¹⁰ *The Spirit of the Garden*, 14.

¹¹ *The Spirit of the Garden*, 15.

¹² As she later described: "In 1902 I was called upon to locate and plan a garden for Mr. Frederick S. Moseley, the only stipulated requirement being that I should make the garden a part of an approach to the already established greenhouses and fruit and vegetable gardens." Martha Brookes Hutcheson, "Report of Work Done on Estate of Frederick S. Moseley, Esq., Newburyport, Massachusetts," typescript draft of documentation submitted to the Secretary of the Examining Board, American Society of Landscape Architects, 12 May 1920, in support of her application for membership, MBHA.

¹³ *Ibid.*

Rebecca Warren Davidson, an architectural and landscape historian, is Curator of Graphic Arts in the Department of Rare Books and Special Collections at Princeton University. This article is excerpted from her introduction to the reprint of Martha Brookes Hutcheson's 1923 *The Spirit of the Garden*, published by University of Massachusetts Press, Amherst, in association with the Library of American Landscape History, 2001.

In her continuing research on Martha Brookes Hutcheson, the author would be most grateful to hear from anyone with additional information about her work at any of the above properties. Rebecca Davidson, davidson@princeton.edu, (609) 258-3197

THE USE OF THE HEDGE

Martha Brookes Hutcheson

HEDGES might be described as that formality of green growth most nearly related to architecture. Indeed, there is so very fine a line between their artificially produced form and proportion and that of an architectural detail that practically they may be thought of as part of the general architectural scheme. It is the meeting-point of architecture and the green world—one of the instances where Nature, harnessed to civilization, does not lose in value. We might compare the hedge to the magic—though artificial—touch which transforms the great forest tree, with all its freedom of growth and beauty of line, into a splendidly wrought column, so full of proportion and dignity that the sisters of the forest, from which it came, might almost envy it.

The hedge is essentially artificial in its original treatment and also in its preservation, and left untouched for a short period, goes back with amazing alacrity to the freer growth which the Lord intended.

Let us begin with our low flower-bed borders, our box and our barberry, and think of them as hedges. They are the little ones, and they creep up in size to those which we look over—which are of enormous use—and to those which are higher than ourselves; and then we begin to think of the stately hedges of box and holly in Scotland and England, and the wonderful yew and ilex hedges which we find in Italy—the backgrounds for the statues; the enclosures for the amphitheatres; the protecting walls behind which romance and intrigue have been born and cardinals have walked.

The hedge is no upstart; it has accentuated scenes of splendor from the earliest times of planting. It has lent itself as gracefully to the merrymakings of the maze as to the gardens of the Roman Emperors.

The great note of all the famous villas of Italy—so wonderful in their outline and proportion that no flowers are needed to make them gardens—is the perfect harmony of idea between the architectural details of steps, pools, and pathways and the walls formed by hedges.

The use of the hedge is a very valuable asset which came into existence as civilization advanced to the point where man first grasped the idea of privacy and individuality about his home. In the very earliest records of gardens there are illustrations of the hedge in the quaintest perspective.



Boboli Gardens, Florence. Green walls formed by clipped shrubbery.

The hedge is an accent, first and foremost, and its purpose is either a background or a barrier. Being artificial, it of necessity should be planted in relation to architecture—that term being used to denote the formalities of garden or parterre arrangement as well as of the buildings proper. A hedge must have a purpose, just as much as a balustrade or a flight of steps; it must be in proportion to its environment, just as much as the house or its garden. It should be looked upon, where it is used as a background, purely as a flat surface against which the informal growth of flowers or the moving figures of people are accentuated. When considered in the larger scheme, where trees in the distance and the perspective of diminishing lines are seen in relation to it, its own sharp outline becomes an important factor. Therefore, two uses are found in the same hedge: in relation to smaller things it is a background, and in relation to larger things, an accent. When

planted in front of old trees, the hedge makes in its contrast, in rigidity of form, a note so firm and controlled as to accentuate the freedom of growth in the trees. It lends a note of variety while suggesting an important one in composition.

As a barrier, the hedge is of practical use and more pleasing to the eye than any other form of fencing. Its most important use is found when planted in front of the houses on a village street. It gives to the street itself, as does nothing else, a style in composition; and from the owner's view within the grounds it makes the place seem larger and more important by cutting off the highway as well as providing a background.

When service-wings of houses lie in close proximity to the garden or terrace, and privacy must be secured though there is limited space, the hedge is of great advantage, as a strip of land from four to six feet wide is all that is needed to screen off that part of the house and to create a background for the terrace or the garden.

In the plantings of gardens, clipped blocks of hedge may be introduced for the purpose of accent or contrast at the crossing of paths and sides of gateways, or

other blocks as backgrounds for seats or fountains. Niches for the placing of statues are frequently found abroad cut into the surface of the hedge and are sometimes carried out in this country with marked success. In the bounding of terraces, where used alone or planted behind a balustrade, a hedge is always dignified, and an important note.

There is a prevalent idea that hedges require great time and care in this country where very high wages are to be considered, but anyone who has had them knows that for what they lend in effect they take comparatively little time. If a hedge is well kept from the beginning, three to six clippings a year are all that are required for the most vigorous. We spend an infinitely greater proportion of time on vast extent of lawns, in relation to the amount of pleasure we derive from them. If there is to be any choice in the things which require labor, do without some unnecessary areas of lawn which take weekly attention, and give a fraction of that labor to hedges.

Climbing roses, if not allowed too much liberty in their growth, make a wonderfully lovely hedge when grown over some artificial support of the shape and height required. Hornbeam, cherry, dogwood, laburnum, arborvitae and dozens of other small trees lend themselves easily to being bent into the form of hedge-like arbors, and with so delightful



A pleached alley.

an effect, that one wonders the charming sense of frolic and surprise is not more sought after by us all. Why are we so contented to pass from one scheme of arrangement to another through barren treatment, when it takes but a hedged-in walk to give us the sensation of a marked place-apart, and makes all the difference in the world in the overlapping interests to be gained by a bit of imagination?

Is there nothing more to be desired in the formal approach to a garden than a gravel path, flanked with the neatly kept turf-edging of a lawn? The path, it is true, is the only bare necessity; but is that all we have to consider? Suppose the path is looked upon as but the backbone of the approach, and we add a broad hedge of great height on either hand, perhaps so planted that three to six feet of margin are left on each side of the pathway for shade-loving flowers? We thus create shadows, a mossy path, an invitation for birds, an increased sense of distance, a vanishing point in perspective, an added lovable feature about our home; and the pathway

has been made a romantic introduction of shade between two interesting open spaces. Children grown to men and women fifty years after will remember the spot with a glow of mystery and pleasure, whereas the barren, well-kept path would be quite forgotten. If a pathway for some reason should not be bordered by a high unbroken line of this kind, it can be flanked by regularly or irregularly planted shrubs, placed as far apart as desired. Cedars, dwarf fruits, thorns, or poplars all form beautiful path-margins of a broken formal type. In England I remember a wonderful hedge on either side of a wide grass-path joining an artist's studio, which was built on the edge of a little wooded piece of land, and his garden, which was by his house some distance away. The path lay in a graceful curve through a grain-field terminating at the studio door. The hedge was formed of sweetbriar rose, kept clipped to a rounded top, standing about four to five feet high. The perfume from the young shoots was pungent and delightful as one passed along the path, and the ripening grain, seen on either side of it, made a fine waving background for the bright green color and formal outline of the hedge.

Clipped perpendicular walls of hedge can be made when a pathway should be introduced through tall swamp- or wild wooded-growth. By introducing a dense natural planting of high-bush blueberry, clethra, the various viburnums and thorns, wild roses, azaleas, barberry, and spice-bush, and by constantly cutting their growth to a true vertical line on each side of the path, a tall and interesting enclosure for a green walk can be formed in a few years. The constant pruning induces a vigor of growth on the face of the green wall which is very beautiful. A consistent choice of natural plants can in this way create a feature leading from one important point to another. The setting of a house, for instance, can—with no false introduction of planting—be connected with an equally architectural garden or tennis court, through a stretch of natural woodland which demands some continuity of treatment.

When entrances through hedges are to be cut in semicircular or "vaulted" arches, it is well to have a frame made of the desired shape and have the hedge-opening cut by this frame year after year. Curved lines when left to the accuracy of the eye are not true, and the general outline suffers in consequence. Our old, much abused friend, the privet, is so inexpensive and so dependable that no one is left with an excuse for going without a hedge wherever one can be tucked in. Arborvitae, buckthorn, hemlock, hornbeam, barberry, beech, and some of the viburnums are more to be desired when one's choice alone is to be considered. Nothing is more tranquil than the quality of green form which good hedge-pruning gives to a composition, and it is far better to have a thousand feet of privet than a few hundred feet of some rarer hedge. The composition comes first and the material used, second, in the importance of hedges.

From *The Spirit of the Garden*, 1923.

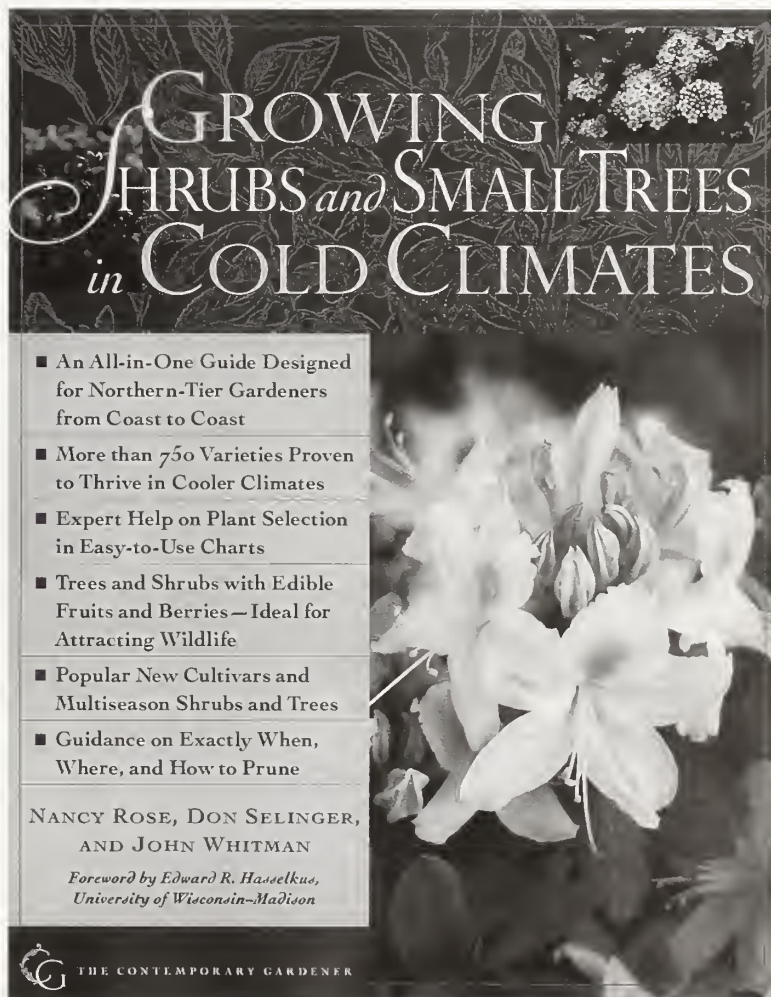
Book Review: *Growing Shrubs and Small Trees in Cold Climates*

Michael S. Dosmann

Growing Shrubs and Small Trees in Cold Climates. Nancy Rose, Don Selinger, and John Whitman. Contemporary Books, 2001. 431 pp., 250+ color photographs. Hardcover. \$49.95. ISBN 0-8092-2491-7

A number of books dedicated to ornamental trees and shrubs rest on my bookshelf gathering dust. Some were valuable in their day but have become out of date with time. Others, though published recently, offer little more than information recycled from other references, or anecdotal information of no use to the serious gardener or horticulturist. But then, much to my surprise and delight, along comes a book like *Growing Shrubs and Small Trees in Cold Climates*.

The authors, all seasoned horticultural professionals, present their collective knowledge about ornamental shrubs and small trees in an easy-to-read format. And although gardeners are targeted as the primary audience, any person who deals regularly with ornamental woody plants will find the book useful. Readers can feel assured that the information is accurate, based as it is on the authors' many years of personal observations and experiences, not hearsay or suppliers' promises. Adding further credence is a foreword by Edward



Hasselkus, professor emeritus of horticulture at the University of Wisconsin.

The theme of cold hardiness is woven into the entire text. As indicated by the title, the book is intended for use in cold climates, primarily the regions encompassed by USDA hardiness zones

1 through 5. Proven hardiness is the major criterion for the authors' recommendations, and their discussion of the topic will be valuable for laypeople and professionals alike.

The book is divided into two parts. Part I, "The Most Popular Shrubs and Small Trees," comprising the bulk of the volume, is organized around fifty woody plant genera within which over 750 different taxa are discussed. I was a bit skeptical at first about the authors' attempt to categorize an entire genus as a single unit, but they are careful to highlight any atypical members. Accompanying each genus entry are outstanding color photographs—a total of more than 250—that include close-up shots of foliage, flowers, and fruit as well as form and habit.

The format is consistent for all entries, with information arranged in clearly defined sections. The section on growth ("How Hydrangeas Grow," for example) provides a good summary of root systems, branching patterns, form and habit, phenology, flowers, and fruiting. The section "Landscape Use" is particularly valuable. Plant uses are classified by the usual categories such as hedges, specimens, groundcovers; more unusual is a list of recommended companion plants that might enable the reader to enhance design effects using complementary textures and flower colors. The "Where to Plant," "Planting," and "Transplanting" sections give thorough details about proper siting and planting methods. The "Problems" section reviews the susceptibilities specific to each genus: insects, diseases, and—a novel category—marauders (primarily deer). Another useful section is "Sources," where specialty nurseries are listed with their addresses and phone numbers. Other topics, all covered in sufficient depth for the layperson, include "How to Care for These Plants" (with clear recommendations for maintenance regimes); "Propagation" (discussing suckering, cuttings, and seed); and "Special Uses" (with instructions for preserving cut or dried flowers).

The final part of each entry, "Varieties," is arranged in chart format and lists recommended species, varieties, and selected clones in addition to giving standard data for each that includes size, flower and fruit color, and hardiness. Almost all taxa are rated on a scale of one through five based on ornamental appeal and performance in cold climates. Additional information provided in the charts or captions might include separate hardiness temperatures for plants and flower buds (*Forsythia*, for example) or recommended male pollinators (*Ilex verticillata*). Missing, unfortunately, is the kind of information that would allow the reader to make clear distinctions among the various cultivars of comprehensive genera like *Syringa*.

The task of deciding which taxa to include in a book like this is a daunting one. While one could identify an omission or two, on the whole the authors have made excellent choices: virtually all the plants covered are deserving of inclusion.

Part II of the book, "The Basics of Growing Shrubs and Small Trees," consists of well-written chapters that discuss in general terms the topics already covered for individual genera: plant selection, site selection and preparation, planting, maintenance, and the like. Terms and concepts are defined with care and clarity, and the glossary at the end of the book is a helpful reference tool. I would have liked the authors to include a "References Used" section with a list of sources for taxonomy and nomenclature, but this is a minor omission; in no way does it affect my hearty recommendation of the book. It has already found a place on my shelf, within arm's reach, and has little chance of collecting dust.

Michael Dosmann is a Putnam research fellow at the Arnold Arboretum, where he writes and conducts research on woody plants in addition to coordinating the plant selection for the new Shrub and Vine Garden.

The Arnold Arboretum

Vol. 61 / No. 1 • NEWS • 2 0 0 1

Summer Storms Leave Their Mark

Stephen Schneider



The collections have benefited from the frequency of heavy rains this summer, particularly in the wake of several dry seasons. However, when accompanied by severe thunderstorms, the rains can have negative consequences. In June and July, the Arboretum suffered four major lightning strikes. Damage caused by these strikes has been significant enough to require heavy pruning on several trees and the removal of two.

Along Meadow Road, specimens of amur cork tree were the first trees to be damaged by lightning this season. The injury to one was eye-catching: when the strike stripped off a wide swath of bark, it exposed a patch of bright yellow and split one major limb down the middle.

Two subsequent strikes disfigured a pair of red oaks and a tulip tree. All three lost significant amounts of bark. The most dramatic event occurred on Hemlock Hill, where two hemlocks were hit and literally blown apart; one is pictured at left. These trees were removed immediately.

Past experience shows that the cork, oak, and tulip trees may survive. Two years ago lightning struck an old black walnut, leaving a large wound running down its trunk. The wound has developed a callus to ward off disease and appears to be recovering.

New Home for a Grand Cherry

A vigorous 60-year-old specimen of *Prunus* 'Karl Sax', originally located in the dwarf conifer collection below the Dana Greenhouses, was moved this spring to its new home in the Eleanor Cabot Bradley Collection of Rosaceous Plants. A cultivar named for former Arboretum director Karl Sax, the tree was moved during site preparations for the Shrub and Vine Garden. Full-grown trees are rarely moved on the grounds, due to their unwieldy weight and the possibility of incurring damage to both limbs and roots. This cherry, in full bloom the week of its relocation, was moved by forklift to the *Prunus* collection near Dawson Pond on Meadow Road. Arborists and members of



Laura Tenny Brogina

the grounds staff carefully replanted the tree, which seems to be adjusting well to its new home.

Dave Russo Distinguished as Harvard Hero

Each year Sally Zeckhauser, Harvard's Vice President for Administration, hosts a reception for individuals designated as Harvard Heroes, an employee recognition program currently in its sixth year. This year Dave Russo, facilities manager, was recognized as the Arboretum's Hero for his exemplary service over the past year. Since his arrival at the Arboretum in March 1999, Dave's



Jon Helman

diligence, resourcefulness, and indomitable humor have made him an invaluable part of day-to-day operations at the Arboretum. In a position that requires he be on 24-hour call, Dave has proven himself an inventive problem solver and dedicated team player. At the ceremony, held at Harvard's august Sanders Theater, Dave was joined by family and coworkers to honor his outstanding contributions to the Arboretum and the Harvard community.

New Staff



Jon Helman

Judy Greene joined the Arboretum in April as a project image cataloger in the Arboretum's Horticultural Library. Under a grant

from Harvard's Library Digital Initiative, she is cataloging photographs taken by Joseph Rock during the Arnold Arboretum's 1924–1927 expedition to western China and Tibet as well as those taken in the 1990s during Harvard University Herbaria collecting trips to these same areas. The images Judy catalogs will be available through VIA, Harvard's online catalog for visual materials, and through a future "Hotspots of Diversity" website. Judy comes to the Arboretum with an MS in

library science from Simmons and an MA in history from the University of Rochester. She has cataloged visual and archival materials for a number of local institutions, most recently Hedda Morrison's photographs of China for the Harvard-Yenching Library and slides of African art for the Fine Arts Library at Harvard. This year Judy was the recipient of Harvard University Library's Bryant Fellowship for her work on the African-American architect Thomas Wilson Boyde, Jr.

Collections Provide Backdrop for Solstice Legends

On two evenings in June storyteller Diane Edgcomb and Celtic harpist Margot Chamberlain entertained Arboretum friends with evening performances of stories and songs celebrating the summer solstice and illustrating—with the help of the Arboretum's living collections—the importance of trees to a variety of cultures. Leading the group out of the Hunnewell building like the Pied Piper, Diane began by recounting an Australian aborigine legend near the cedar of Lebanon just outside the visitor center. The group then moved along Meadow Road to enjoy a Native American legend near the giant silver maple and a Japanese tale of love under a Sargent's cherry. Next Diane and Margot led the group onto Beech Path for a Celtic tale of tree spirits entitled "Three Green Ladies," followed by a stream-side performance under a hemlock tree in Rhododendron Dell and a Welsh song about the cuckoo on



Pamela Thompson

Valley Road. At the final stop, among the birches on Valley Road, the performers enchanted the audience with a Czechoslovakian story told in song and dance about how birches got their stripes. Both evenings were a great success.

Stone Walls Erected in Shrub and Vine Garden

Construction of the new shrub and vine garden has been swiftly gaining momentum since it was begun in May 2001. Dramatic changes become evident almost daily, but perhaps the most satisfying has been the emergence of the stone walls that will hold the planting terraces.

A crew of five to eleven masons from Portsmouth, Rhode Island, have been working their way uphill on the site, transforming loose piles of rounded, weathered fieldstones into walls of broadly curving arcs with crisp, square corners. Each stone is shaped, placed, and mortared by hand. Larger stones weighing 200 to 300 pounds require two men to heave them into position.

Much of the fieldstone is purchased and moved from old farm pasture walls in west-

ern Massachusetts and Connecticut—a common source of fieldstone used for construction in the Boston area.



Laura Jenny Brogna

An Evening of Discovery Among the Roses

Karen Madsen



On a splendid evening in June, members of the Director's Advisory Board and the Arboretum Council gathered with friends of the Arboretum in the Eleanor Cabot Bradley Collection of Rosaceous Plants.

Guests were offered a tour of the collection led by members of the living collections staff, who discussed the origins and growth habits of a wide variety of rosaceous plants. The plants included in the tour were chosen to illustrate the broad diversity of this plant family as well as to highlight members that are particularly beautiful, adaptive, or endan-

gered. The tour began with *Rosa* 'Duchesse de Montebello', a favorite of the collection's benefactor, Eleanor Bradley, that was originally grown in her garden in Canton, MA. Affectionately referred to as "Mrs. Bradley's rose" by members of the staff, this fragrant pink rose has almost completely thornless stems. Many guests on the tour took the opportunity to chat with Kirsten Ganshaw, the gardener of the collection, whose hard work and expertise were evident throughout the collection.

After the tours, guests were formally welcomed to the festivities by director Robert E. Cook and Director's Advisory Board co-chair A. David Davis. Informal presentations by Elizabeth C. Sluder, daughter of Eleanor Cabot Bradley, and Stephen Sponberg, executive director of the Polly Hill Arboretum and one of the architects of the collection, added a historical perspective.

A map of a self-guided tour of the Bradley Collection is on sale at the Hunnewell Visitor Center. Take a walk and learn more about this fragrant and fascinating plant family!

21st Annual Fall Plant Sale

Rain or shine, you're sure to find something spectacular for your garden at the Annual Fall Plant Sale on Sunday, September 16, 2001, at the Case Estates in Weston. One of the most anticipated horticultural events in New England each year, the Plant Sale is an Arboretum tradition currently in its 21st year.

Over 100 varieties of trees, shrubs, vines, and perennials, many cultivated from clippings and seeds from the Arboretum's living collections, will be sold in and around the barn. Featured this year are two new Arboretum plant introductions, *Liquidambar*

acalycina and *Fothergilla gardenii* 'Harold Epstein', as well as beautiful specimens of *Cornus controversa*, *Acer triflorum*, and *Euonymus carnosus*, to name a few. The barn will open to members at the sustaining level and above at 8:00 a.m., to all members at 9:00 a.m., and to the general public at 10:30 a.m.

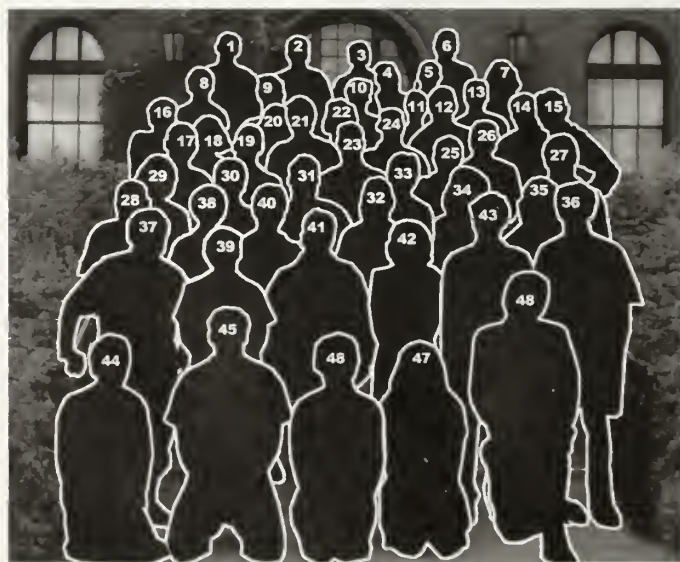
This year's sale will also feature the return of the Collector's Choice tent and the Live Auction, which includes choice and unusual plants generously donated by nurseries and individuals nationwide. Arborists from the staff will be on hand to answer questions about the care of woody plants.

Further expert advice and specialty plants may be garnered from the propagators on 'Society Row', representing over twenty plant societies from all over New England.

For more information about the plant sale, to donate plants, or to become a member or upgrade your current membership with the Friends of the Arnold Arboretum, please call Jon Herman at 617.524.1718 x 145. Members will receive a catalog of plants to be offered in the barn in August and will receive free plants and a discount on plant purchases at the sale!

Staff Photo

On the facing inside cover is the staff of the Arnold Arboretum as it was photographed recently for the first time in many years. Below is a key for linking names to faces. Absent on that day were Tom Akin, Kenneth Clarke, Carol David, Hans-Joachim Esser, Stuart Lindsay, Sandra Morgan, Bruce Munch, Jim Nickerson, Karen Pinto, Dave Russo, Lisa Schultheis, and Emily Wood.



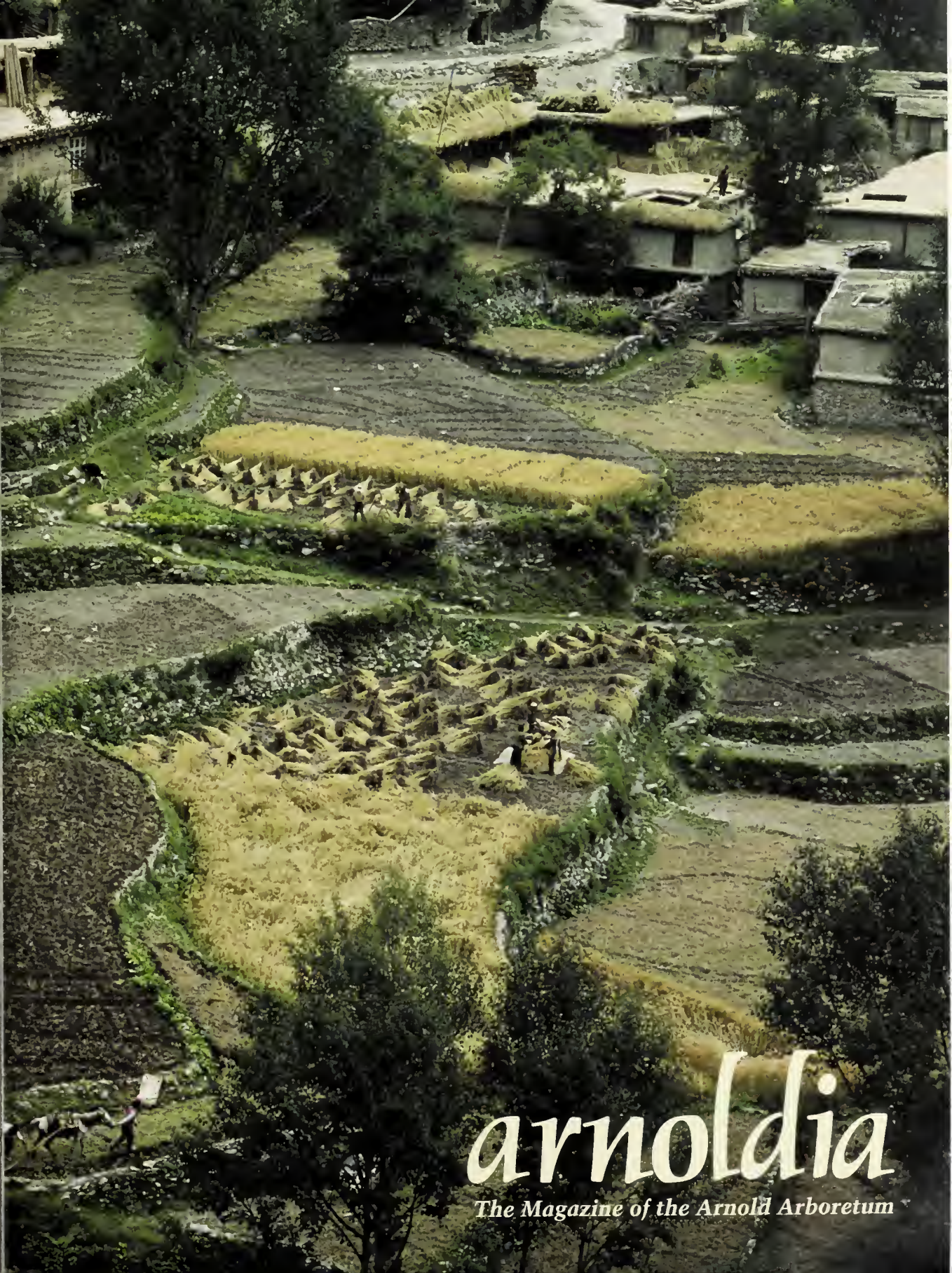
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2. Terry Sharik
3. Sheryl Barnes
4. Nancy Sableski
5. Julie Coop
6. Tom Ward

7. Ellen Bennett
8. Jon Hetman
9. John Olmsted
10. Kyle Port
11. Susan Kelley
12. David Boufford

13. David Middleton
14. Dennis Harris
15. Moe Sheehan
16. Karen Madsen
17. Stephen Schneider
18. Phyllis Andersen
19. Michael Dosmann
20. Candace Julyan
21. Jack Alexander
22. Irina Kadis
23. Joseph Melanson
24. Thomas Por
25. Donna Barrett
26. Kirsten Ganshaw
27. Bob Cook
28. Mark Walkama
29. Judy Warnement
30. Sheila Connor
31. Bob Famiglietti
32. Laura Tenny Brogna
33. Susan Hardy Brown
34. Alice Ingerson
35. Judy Greene
36. Donald Garrick
37. James Papargiris
38. Bethany Grasso
39. Chris Santos
40. Frances Maguire
41. Sheila Baskin
42. Pamela Thompson
43. Jianhua Li
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46. Sonia Brenner
47. Kirstin Behn
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Karen Madsen, *Editor*
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Andy Winther, *Designer*

Editorial Committee

Phyllis Andersen
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Front & back cover: The barley harvest in southeastern Tibet photographed by Susan Kelley in July 2000. Barley is the only crop that grows at the high elevations of the Tibetan Plateau.

Inside front cover: E. H. Wilson photographed the "Knight" elm, near Newburyport, Massachusetts, in 1927. He measured its girth at 18 1/2 feet four feet from the ground and 46 feet at ground level. From the Archives of the Arnold Arboretum.

Inside back cover: The "Howard" elm in Ware, Massachusetts, measured over 19 feet in circumference at three feet from the ground and 100 feet through the crown when E. A. Richardson photographed it in 1904. From the Archives of the Arnold Arboretum.



Anachronistic fruits of North America. Photograph by Connie Barlow.



Plant Hunting on the Rooftop of the World

Susan Kelley

Plant exploration has always played an important role in shaping the Arnold Arboretum's collections and has been the driving force behind the many Arboretum-sponsored trips to the Far East and within North America. Living plants grown from seeds gathered on these expeditions grow on the grounds of the Arnold Arboretum, in the collections of other botanical institutions in North America and abroad, in the stock inventories of nurseries across the country, as well as in our own home gardens. Although new plant material from expeditions is added to the living collections each year, the main goal of the majority of Arboretum-sponsored fieldwork is the creation of botanical inventories of eastern and south-eastern Asia in the form of herbarium vouchers. In fact, few people familiar with the Arboretum's collections in Jamaica Plain are aware of the institution's collection of approximately 1.4 million herbarium specimens housed in the Harvard University Herbaria in Cambridge, Massachusetts (<http://www.huh.harvard.edu/>).

In 1997, under the auspices of the Biotic Surveys and Inventory program of the National Science Foundation (NSF), the Arnold Arboretum began a three-year collaborative effort to inventory the plant and fungal diversity in the Hengduan Mountains of south-central China, one of the unique biological regions of the world. Lying at the eastern end of the Himalayas between the edge of the Qinghai-Xizang (Tibetan) Plateau and the central plain of China, these spectacular north-south trending ridges contain the most diverse vascular plant flora of any region of comparable size in the temperate zone. Identified as one of twenty-five biodiversity "hotspots" on earth,¹ this vast region, covering an area of approximately 300,000 square miles (500,000 sq km), contains over 12,000 species of vascular plants, with

almost 3,500 endemic species and at least 20 endemic genera.

Although some botanical exploration has previously been carried out in the Hengduan Mountains, the region has never been fully inventoried because of the sensitive political atmosphere in Tibet and because the rugged terrain makes much of the area extremely difficult to traverse. Elevations range from 3,300 feet (1,000 m) to over 25,000 feet (7,556 m) at the summit of Gongga Shan in western Sichuan. Average elevation is 10,000 to 13,000 feet (3,000 to 4,000 m) with precipitous drop-offs of 1,000 to 3,000 feet (300 to 900 m) not uncommon. No one, however, has yet identified the full extent of the geography and plant life of this particular "hotspot."

The term "hotspot," coined in 1988 by British ecologist Norman Myers, is used to designate areas that have a high number of endemic species (those whose distribution is limited to a single region) and that are under severe threat of destruction because of human activities. These threatened regions cover less than two percent of the earth's land area, but are home to more than sixty-five percent of all vascular plant species. Of the twenty-five designated hotspots, the Hengduan Mountains and the California Floristic Province are the only two located in the Northern Hemisphere. All other hotspots, with the exception of central Chile, the Cape Province of South Africa, and southwestern Australia, are located in the tropics.

The Hengduan Mountain region, as currently defined, constitutes only five percent of China's land area, occupying portions of southeastern Xizang (Tibet), western Sichuan, and northern Yunnan, but it contains almost half the total number of all Chinese flowering plant species. The extremes in climate and topography almost certainly contribute to the diversity of plant life



The Hengduan Mountain region, one of the twenty-five biodiversity hotspots of the world.

there. More than a quarter of the world's *Rhododendron*, *Primula*, *Corydalis*, *Delphinium*, *Anaphalis*, *Gentiana*, *Saussurea*, and *Sorbus* species and over half the species of *Ligularia*, *Cremanthodium*, *Cotoneaster*, and *Pedicularis* have been recorded here. In addition, there may be as many as fifty species of endemic mosses.

A few numbers will illustrate the extent of some particularly species-rich groups in the spectacularly diverse Hengduan region (approximate numbers of species worldwide in paren-

theses²: *Rhododendron*—224 (850); *Androsace*—28 (100); *Primula*—113 (400); *Gentiana*—117 (350); *Saussurea*—101 (300); *Impatiens*—45 (850); *Pedicularis*—250 (350+); *Aconitum*—104 (100+); *Delphinium*—71 (250); *Arisaema*—39 (150); *Cotoneaster*—41 (50); *Astragalus*—98 (2,000); *Ilex*—44 (400); *Corydalis*—85 (300); *Sorbus*—36 (85); *Anaphalis*—33 (100).

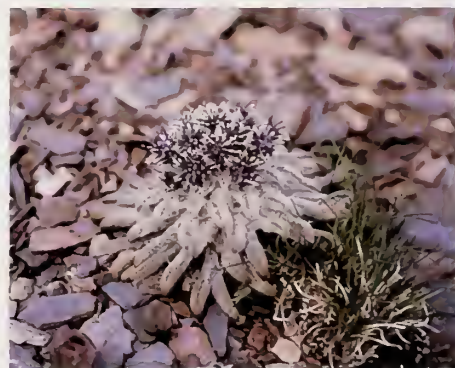
The table on the opposite page compares the levels of diversity and endemism in the Hengduan region with those of other nontropical areas, providing another indication of its richness.³

Four of the great rivers of Asia, the Yangtze (Jinsha Jiang), the Mekong (Lancang Jiang), the Salween (Nu Jiang), and the Brahmaputra (Yarlung Zangbo Jiang), flow through the valleys of these dramatic mountains. All of these rivers

originate on the 16,500-foot (5,000-m) high Qinghai-Xizang (Tibetan) plateau, and, far downstream, all are of great economic importance to the people who live along them. The rapidly increasing human impact on the region threatens not only the diversity of plants and animals there, but also the survival of indigenous cultures that define much of eastern and southeast Asia.

In the summer of 2000, the third year of the NSF project, fieldwork was conducted for two

SUSAN KELLEY



Three species of *Saussurea*, a member of the aster family: above, a cushion form growing on scree slopes at 17,000 feet; left and center, two species grow among boulders at 15,000 feet.

Region	Area (km ² x 1000)	Number of genera	Genera endemic (%)	Number of species	Species endemic (%)
Hengduan Region	500	1467	20 (1.4)	8559	1281 (15.0)
California	411	878	26 (3.0)	5046	1517 (30.1)
California Floristic Prov.	324	795	50 (6.3)	4452	2125 (47.7)
British Isles	308	545	0 (0)	1443	17 (1.2)
Cape Province, South Africa	0.47	533	1 (0.2)	2256	157 (7.0)
Carolinas	217	819	1 (0.1)	2995	23 (0.8)
Gray's Manual range	3238	849	6 (0.7)	4425	599 (13.5)
Japan	377	1098	17 (1.5)	4022	1371 (34.1)
Texas	751	1075	7 (0.7)	4196	379 (9.0)

months in southeast Xizang (Tibet) by a team of four American, one Tibetan, and four Chinese botanists. Dave Boufford, assistant director of the Harvard University Herbaria and an author of the NSF grant proposal, headed the American team. I was fortunate to be part of that team, along with Rick Ree, who received his Ph.D. from Harvard this year and works on the genus *Pedicularis* (lousewort), and Brian Perry, a doctoral student at Harvard in mycology. Four Japanese botanists traveled and collected with the group as well, but were not working under the auspices of the NSF grant.

The logistics of the expedition were coordinated by Wu Sugong of the Chinese Academy of Science Institute of Botany in Kunming in Yunnan Province. Professor Wu had done fieldwork in the area in the 1970s and 1980s and helped compile the two-volume checklist *Vascular Plants of the Hengduan Mountains*.⁴ His position was not an enviable one, since efforts to arrange permits, lodging, and rations were continually complicated and delayed by landslides, broken-down vehicles, massive roadway

construction projects, obstinate local officials, and inclement weather.

The expedition team assembled at the Kunming Botanical Garden on June 28, 2000. There we handed over our passports to a young Tibetan woman, Yang Zhen, who was to fly them to Lhasa to obtain permits for travel in the Tibet Autonomous Region. While waiting for her return, we drew up the final itinerary and gathered equipment: plant presses, ventilators, portable dryers, kerosene burners, a fifty-gallon drum of kerosene, food, camping gear, and even an extra pair of springs for the rather rickety bus that was to transport much of our equipment. Little did I suspect how valuable these springs would prove to be weeks later down the incredibly rough road.

Finally, on July 4, with three SUV's and a small bus, we began our journey north. The fully loaded truck remained in Kunming to wait for our passports and the all-important permits to arrive from Lhasa. For the next several days we headed north, stopping in the towns of Dali,



Wu Sugong and Dave Boufford.

Zhongdian, and Degen. In Dali, a popular Chinese tourist destination situated next to Lake Erhai, we encountered a few Tibetan vendors whose wares included fruiting bodies of the *Cordyceps* fungus, a dried tiger penis ("For your health!"), and the antlers of an unidentified antelope. We took advantage of the town's internet café, which would be the last we saw until we reached Lhasa on August 17.

During the eighth and ninth centuries, Dali was the capital of a separate kingdom, Nanzhou. The local Bai people—who ruled from 902 until 1252, when Kublai Khan conquered the area—renamed it the kingdom of Dali. Diancang Shan, an uplifted mountain of granite and marble, rises 13,500 feet (4,100 m) just west of the city. Since most of the remainder of the province of

Yunnan is limestone, the flora of Diancang Shan is distinctive and interesting in and of itself. In 1984 Dave Boufford spent six weeks collecting herbarium specimens there; on this trip we could spend only a day on the mountain.

Heading north we saw fields of tobacco, corn, rape seed (used for cooking oil), cabbage, beans, and peas. Large *Populus yunnanensis* grew along the roadsides, but most of the land was stripped completely of woody vegetation. Joseph Rock, the Viennese-born botanist, ethnologist, and linguist, made his home in Lijiang for some thirty years. Between 1924 and 1927, he collected hundreds of herbarium specimens for the Arnold Arboretum and sent back seed of many new plants for its living collections.⁵

For more than an hour the road followed the Yangtze River (Jinsha Jiang), a broad, muddy expanse. The weather was warm, but clouds prevented us from seeing Yulongxue Shan (Snow Mountain), at 18,467 feet (5,596 m) the highest in Yunnan. Growing on the roadside were species of *Philadelphus* (mock orange), *Sambucus* (elderberry), *Pyracantha*, *Indigofera* (indigo), juniper, and an evergreen oak with a dense covering of yellow-brown hairs on the

underside of the leaves. By the time we reached Zhongdian early in the evening, we had gone from an elevation of 7,000 feet (2,100 m) in Dali, to about 10,500 feet (3,200 m).

Zhongdian, close to the Tibetan border, was the first town in which we saw a sizable population of Tibetans. Some of the shops had Tibetan goods for sale, such as silver bracelets, coral and turquoise necklaces, daggers, and clothing. The architecture of the town, however, was typical Han Chinese white tile buildings. Alongside the modern food shops, banks, restaurants, hotels, and CD and DVD shops, pigs ran in the muddy streets and vendors in open-air markets offered housewares, horse blankets and saddles, fresh yak meat, live chickens and fish, vegetables, brooms, baskets, pots and pans. One vendor had



SUSAN KELLEY

Rheum nobile, a type of rhubarb (also seen in closeup at right), and several species of *Primula* grow near Tiensi Lake in northern Yunnan.

stacks of fresh yak butter, which I had tasted that morning in a bowl of tea. In the outlying areas, we saw the first signs of Tibetan architecture, square, two-story stucco structures, painted white but with colorful decorations around the doorways and windows. Buddhist prayer flags flew from the rooftops.

We spent two days in Zhongdian, waiting for Yang Zhen to arrive with our passports and the permits needed to cross the provincial border into Tibet. We spent the time exploring the vegetation in the mountains outside Zhongdian. Lake Tiensi, at 13,500 feet (4,100 m), is a beautiful alpine lake about two hours from Zhongdian. Growing there among grazing yaks, we found *Rhododendron wardii*, a tall rhododendron with pale yellow flowers named for British botanist Frank Kingdon-Ward. Between 1909 and 1957, Kingdon-Ward introduced hundreds of new species into cultivation (rhododendrons, primroses, gentians, the Himalayan blue poppy) from here and other parts of western China and from upper Burma and French Indochina. We also found the distinctive *Rheum nobile*, a rhubarb with large, pale yellow bracts; purple and yellow species of *Primula*; and a yellow *Mecanopsis*, the Himalayan poppy. Two curious Tibetan boys, perhaps nine or ten years old, appeared seemingly out of nowhere. Although initially quite shy, they followed us at a distance and eventually helped our mycologist find several interesting fungi.

Our second day in the Zhongdian area was spent in drizzling rain at Shudu Hu, another alpine lake, this one surrounded by heavily grazed meadows with patches of cut-over spruce forests. Scattered in the meadows were primroses, asters, gentians, and *Stellera chamaejasme*, a member of the thyme family whose corolla color varies from yellow to pink across its geographic range and even in single populations.

From Zhongdian we drove toward Deqen, closer to the Tibetan border. In the early afternoon we reached a 14,000-foot (4,250-m) pass where for the first time we saw Tibetan nomad tents woven of black yak hair, with large branches of juniper propped against the doors for insulation. A few specimens of *Pinus armandii*, almost 60 feet (18 m) high, with bright green, pendulous cones, were growing there along with a few specimens of *P. yunnanensis* and *P. densata*, but most of the woody vegetation had been cut for fuel or lumber. (There is a nice 65-foot [20-m] specimen of *P. armandii* on Peters Hill that was grown from seed collected in 1909 by William Purdom in Shaanxi Province, to the northeast of the Hengduan Mountains.)

On July 11 we finally crossed into the province of Xizang (Tibet), descending from almost 11,000 feet (3,265 m) in Deqen to 7,000 feet (2,100 m) on the banks of the upper Mekong River. The landscape here was dry and sparsely covered with scrubby vegetation, with a few



low, cut-over shrubs and many herbaceous plants growing along the road. Following the road up from the Mekong, we came to the village of Yenjing where we had lunch in a low, dark, wooden dwelling (complete with satellite dish on the roof), with almost unbearable smoke flowing from the cooking area.

Within fifteen minutes of leaving town, we climbed another 1,000 feet (300 m) and soon began seeing mixed broadleaf deciduous and conifer forests of *Salix*, *Abies*, *Populus*, *Cornus*, and *Quercus*, along with many herbaceous alpine plants growing by the roadside. After two hours we reached yet another 14,000-foot (4,250-m) pass, Hong La, and began the descent to the town of Markam. The fifty-four-mile journey from our lunch spot had taken more than three-and-a-half hours over rough, narrow roads that required our drivers to negotiate numerous hairpin turns and the remains of recent landslides overlooking precipitous drops of more than 1,000 feet (300 m).

Markam, lying in a long, wide valley created by a tributary of the Mekong, is truly a Tibetan outpost, a primitive, extremely poor town with red mud everywhere and a wild west look to it.

It seemed strange amidst the squalor to hear chants emanating from the walls of a Buddhist temple. While most Tibetan men wore traditional long, fur-lined coats with one sleeve hanging off the shoulder, a few wore Chicago Bulls jackets. The women, in traditional dresses called *chhubas*, stared at us as we walked down the street. A large group of local people followed us to our Chinese guesthouse. It was a bit unnerving to have five or six of them watching from the doorway, long silver daggers hanging from their belts, as we pressed plants and entered data into our laptop computer. Another guesthouse—a government-sponsored temple-restoration project—and the early-morning radio news that blared out from speakers on tall poles were the only signs of non-Tibetan



Dave Boufford bargaining with Tibetan men in Markam.

influence. In fact, this would be the only town in which we saw vestiges of the Tibetan culture, albeit in shambles.

The following day we retraced the road to Hong La (Pass), south of Markam, and made ninety-six collections of vascular plants and mosses in a mixed broadleaf deciduous and conifer forest. Two government officials accompanied us, but they seemed quite uninterested in our work. For two more days we collected in different habitats around Markam. Heavily grazed meadows of grass and *Kobresia*, a type of alpine *carex*, were dotted with scrubby rhododendrons and remnants of spruce and juniper forests. Many genera were very familiar to Western eyes: *Gentiana*, *Ligularia*, *Lonicera*, *Berberis*, *Carex*, *Clematis*, *Rubus*, *Anemone*,

DAVE BOHUFORD



Flowers of *Clematis* climbing on shrubs at a forest's edge near Nyingchi in southeastern Tibet.

Trollius, *Potentilla*, *Pedicularis*, *Picea*, *Campanula*, *Cerastium*, *Polygonum*.

Three days and fifty-some collections later, we headed northwest, climbing another pass above the Mekong River. Apricots were ripening above 12,000 feet (3,665 m), as well as dark blue *Delphinium*, tall *Thalictrum*, and several ferns. The landscape was vast, and although a few scattered pine, spruce, and juniper remained, there was much evidence of clear cutting. Our sense of the strangeness of this land was intensified by the sight of three monks on the road in long, heavy carmine robes, making their pilgrimage to Lhasa, some 400 miles (250 km) away.

It was at Dongda La, south of Zogong, that we hiked to 17,500 feet (5,300 m) to collect alpine perennials from the scree slopes. In the level areas of the glacial cirques, we collected two Himalayan poppies (one blue and one an intense yellow), a creeping willow, several species of rhododendron, and dozens of tiny herbaceous plants. The diversity in this barren landscape was amazing:

SUSAN KELLEY



A species of *Meconopsis*, the Himalayan blue poppy, growing at 17,000 feet at Dongda La.

in the three days that we spent around the town of Zogong, we collected 57 flowering plants and over 140 mosses.

While we collected in the field, Wu Sugong drove to Changdu (Qamdo) to obtain permits for traveling west to Lhasa across the northern road of the Plateau. The local officials in Zogong had informed us that a major bridge had washed out west of the town of Bomi, so the southern route would be impossible to negotiate. On July 19 the entire team set out for Changdu, a 45-mile (75-km) trip that would take six hours because of the now familiar delays caused by road construction, landslides, and generally rough roads.

Changdu, the second largest town in Tibet, lies on the banks of the muddy Mekong and was once a thriving population center. Its large monastery complex, dating to 1444, formerly housed more than 5,000 monks. Only a few hundred monks remain today, but the Chinese government is providing funds to restore their living quarters and the many temples of the lamasery. Elsewhere in the town, however, all traces of Tibetan culture are being destroyed to make room for more modern Chinese architecture and goods. Although Changdu lies on the main road from Sichuan and attracts many tourists from that province, its best hotel can offer hot running water for only one-and-one-half hours each night, and even that isn't guaranteed. Massive construction projects throughout the city often disrupt the basic services that Westerners take for granted.

Our group was able to spend only one day collecting along the Mekong River south of Changdu. The dry slopes and ravines harbor a xeric shrub vegetation dominated by herbs and grasses. Among the thirty-four species we collected were *Salweenia wardii*, an endemic member of the pea family, and *Tribulus terrestris* (devil's thorn), which grew for many years in California as a noxious weed that has only recently been eradicated.

Most of the expedition's fieldwork had been scheduled to take place around the southern townships of Bomi, Yigong, and Nyingchi. The news about bad road conditions west of Bomi now made a long stay there unfeasible if we were to arrive in Lhasa on schedule, but we were determined to spend at least a few days in the area.

The trip to Bomi from Changdu took ten days, but along the way we collected in a number of interesting habitats. On the outskirts of Banda, a tiny outpost consisting of two restaurants, a few shops, a primitive guesthouse, and a Chinese army base, we collected for two days. We spent the first day along a steep, gravelly mountain slope (15,700 feet; 4,760 m) and at the crest of a limestone ridge in a *Kobresia* meadow with *Potentilla*, *Sibiraea*, *Rhododendron*, and *Salix* shrubs interspersed with species of *Corydalis*, *Lonicera*, *Caragana*, *Spiraea*, *Paraquilegia*, *Lepisorus*, *Cryptogramma*, *Pedicularis*, and *Draba*. On the second day we ventured east of Banda to a dry ravine and slope just above the Mekong River. There we encountered a family of Tibetan children collecting firewood, and throughout the day we could hear them laughing, talking, and singing. The woody plants had all been cut by the local people, but a rich flora remained. Among the fifty taxa we collected that day were *Gentiana*, *Geranium*, ten species of *Pedicularis*, *Ranunculus*, *Stipa*, *Rheum*, *Allium*, *Artemisia*, *Silene*, and *Astragalus*.

On July 24 we began our serious push west to Bomi. Our caravan and the other vehicles traveling along this road were forced to negotiate around numerous landslides and road construction projects. Indeed, the sixty-mile journey to the town of Baxio took almost ten hours. Having crossed several more mountain passes, we were now in the Salween River valley. The Salween is as muddy a river as the Yangtse or

the Mekong, but the land around it is as dry as any desert, and the vegetation is sparse.

In the small village of Rawu we saw evidence that deforestation was occurring to the west. Large trucks were unloading logs up to three feet (one m) in diameter in the local lumberyard. Our accommodations in Rawu were in the military compound, where we took our meals with members of the Chinese army and watched them perform their early morning drills. We spent four and a half days in and around this beautiful valley: on the moist, open slopes along Rawu Lake; in alpine meadows; on grazed slopes dotted with *Juniperus*, *Rhododendron*, *Salix*, *Sorbus*, and *Potentilla glabra*; on a boulder-strewn mountain slope along the Palongzang River; and in a broad, gravelly floodplain dominated by small specimens of *Hippophäe*. (This genus, a member of Elaeagnaceae, contains three species. The Arboretum has made several attempts to grow *H. rhamuoides* (sea buckthorn) and *H. salicifolia*, but conditions in the Boston area do not appear to be ideal for these taxa.) One particularly cold, miserable day, we were invited into the tent of a Tibetan family to sit by an open fire and drink fresh, hot yak milk and eat tsampa, a mixture of ground, roasted barley and warm yak milk. We watched with fascination as the family made fresh yak cheese and accepted their gracious offer to share it with us.

The region around Bomi, which we finally reached on July 30, supports mixed semi-humid broadleaf forests of deciduous species such as



Two species of gentian, both growing in thin mountain soils. The blue flowers, in photo at right, are scarcely larger than one centimeter across.



A hospitable Tibetan family boiling fresh yak milk inside their tent.

Betula, *Alnus*, and *Sorbus*. Conifer forests at higher elevations are dominated by *Abies*, *Tsuga*, and *Pinus densata*. Other familiar taxa we saw included *Rosa*, *Populus*, *Lonicera*, *Ribes*, *Rubus*, *Primula*, *Gentiana*, *Rhododendron*, *Cornus*, *Potentilla*, *Sambucus*, *Viburnum*, *Berberis*, *Rhus*, *Elaeagnus*, *Quercus*, *Philadelphus*, *Clematis*, *Prunus*, and *Daphne*. One nice surprise was finding *Lindera obtusiloba* growing wild. (A 100-year-old specimen of this species, grown from seed collected in 1892 in Japan by Charles Sargent, stands across from the lilacs in the Arboretum.) Unfortunately, an unwelcoming attitude on the part of local officials forced us to cut short our time in Bomi; nevertheless, we collected about 125 taxa in the course of our three days there.



Fruit of a *Viburnum* growing at the edge of a forest near Bomi.

On August 4, we retraced our steps toward Banda and then headed north again to Changdu, where we remained for two days while Wu Sugong again met with local officials and made plans for the difficult road ahead. The five-day, 750-mile (465-km) journey from Changdu to Lhasa featured several of the by-now-all-too-familiar hazards of bad roads and washed-out bridges. Twice (once in the dark) we were forced to ford rivers so deep that the water poured over the hood of the vehicles and then rose up through the floorboards. After one night in Lhasa we headed southeast, back toward the Bomi region, to spend four final days in the field.

The more than 6,700 specimens (18,883 sheets) collected over the course of this three-year NSF project will no doubt help to define more precisely this critical biodiversity hotspot. All of the collection and locality data, as well as the images from these trips and others in the region, are linked to a geographic information system (GIS) and are available over the worldwide web (<http://maen.huh.harvard.edu:8080/china>). Specimens collected earlier in the region and now housed in the Harvard University Herbaria will be entered into a database and linked to the website in the near future. By providing training and computer equipment for American and Chinese students and professionals, the project laid the foundation for future long-term research projects on China's biodiversity. In addition, the research may have paved the way for conservation efforts and for detailed analyses of biogeographic patterns and processes of diversification.



Fruit on stump sprouts of a *Sorbus* species growing on grazed slopes near Rawn.



The author collecting in a meadow outside Markam.

tion in the region. Conservation International (<http://www.conservation.org/xp/CIWEB/home>), an organization that is currently working closely with Chinese botanists and government officials in western Sichuan to prioritize areas for conservation, has sought the expertise of Dr. Boufford, who has over twenty years of field experience in China.

Now, after a year's work, we have finished sorting these specimens and dividing them into sets for distribution to over a dozen other botanical institutions. The hardships of the trip are long forgotten, and the magic and richness of this remote, exotic land once known as Shangri-La beckons again. Who knows what other botanical treasures are still to be discovered on the rooftop of the world?

Notes

- ¹ N. Meyers, 1988, Threatened biotas: 'Hot spots' in tropical forests, *Environmentalist* 8: 187–208;

E. O. Wilson, 1992, *The Diversity of Life*. Harvard University Press (Cambridge).

² From D. J. Mabberley, 1987, *The Plant Book*, Cambridge University Press.

³ P. H. Raven and D. I. Axelrod, 1978, Origin and relationships of the California flora, *University of California Publications in Botany* 72.

⁴ W. T. Wang, S. G. Wu, K. Y. Lang, P. Q. Li, F. T. Pu, and S. K. Chen, eds., *Vascular Plants of the Hengduan Mountains*, 1993, Vol. 1, Pteridophyta, Gymnospermae, Dicotyledoneae (Saururaceae to Cornaceae); 1994, Vol. 2, Dicotyledoneae (Diapensiaceae to Asteraceae) to Monocotyledoneae (Typhaceae to Orchidaceae).

⁵ S. B. Sutton, 1974, *In China's Border Provinces: the Turbulent Career of Joseph Rock*, Hastings House, (New York).

Susan Kelley is an associate curator and responsible for managing and developing the Arnold Arboretum's digital mapping system, which tracks the ca. 15,000 plants in the living collections. Her previous experience plant-hunting in Asia was in the central mountains of Taiwan.

Anachronistic Fruits and the Ghosts Who Haunt Them

Connie Barlow

Thirteen thousand years ago, the Age of Great Mammals came crashing to a close in the Western Hemisphere. Lost were the giants of the elephant clan: the mammoths, mastodons, and gomphotheres, which had maintained a presence in North America for twenty million years. The native horses, a tall camel, and all but one species of pronghorn—each group from a lineage thought to have originated in North America—vanished from the plains. Gone, too, were the strange beasts that had evolved in South America during millions of years of continental isolation: ground sloths as massive as elephants, hippo-like toxodons, and lumbering, spike-tailed glyptodonts, which looked uncannily like the ankylosaurs that had shared the Cretaceous landscape with *T. rex*.

These large herbivores (along with the biggest bear, the biggest canid, and several big cats, all of which depended upon the plant eaters) disappeared in a geological instant. Evidence is mounting that newly arrived humans with formidable stone-tipped spears of Clovis design were to blame.¹ This “extinction of the massive” that marks the end of the Pleistocene epoch ravaged the megafauna. What happened to the plants?

We cannot be sure. Leaves and flowers and seeds are not preserved as readily as bone. Plant lineages restricted to upland habitats may come and go without a trace. Bogs and lakes, of course, receive a shower of pollen, often from vast distances. But detectable quantities of pollen preserved in sediments are restricted to wind-pollinated plants—notably, grasses, coni-



*Reunited: osage orange and mastodon. Shown here is surely the first time in thirteen thousand years that the fruit of osage orange, *Maclura pomifera*, has touched a molar of its missing partner in evolution, *Mammuth americanum*.*

fers, and many deciduous trees of our temperate forests. (And of these, some produce pollen that can be distinguished only at the genus or even family level.) Indeed, fossil pollen from stratified bog and lake sediments is the primary evidence used to reconstruct the vegetational shifts that accompanied the repeated coolings and warmings of the Pleistocene epoch.

The Pleistocene pollen record shows only one tree extinction (a species of spruce) in North America near the end of the epoch.² Is there reason to suspect that plants pollinated by insects, birds, or bats—that is, plants with little or no pollen record—might have been more vulnerable to extinction?

The answer is yes, but vulnerability to extinction in this case has nothing to do with the mode of pollination. Many plants that are pollinated by animals rather than by wind produce fleshy fruits whose seeds are dispersed by other, larger animals. Plants dependent on megafauna for dispersal would indeed have been vulnerable to range reduction or even outright extinction when their partners in evolution and ecology vanished.

Riddle of the Rotting Fruit

Ecologist Dan Janzen speculates that although fossil evidence is lacking, some fruit-bearing plants probably did follow the megafauna into extinction.³ These plants would have begun to decline when their megafaunal seed dispersers vanished. Some might have gone extinct relatively soon after losing their partners. Others, especially the long-lived and those that regenerate clonally from their roots as well as from seed, still survive but may ultimately be on track for extinction. Still others have been regenerated as domesticated cultivars by humans fond of their fruit or other botanical qualities. But by and large Janzen thinks that those that are still here today suffered significant reductions in range when important members of their disperser guilds were extinguished.

The narrowly restricted ranges of some of today's big-fruited plants suggest that Janzen may be right: plant extinctions may, in fact, have stemmed from the animal extinctions. An indicator that something is amiss is evident in the case of trees whose fleshy fruits fall and rot beneath the canopy of the parent. It was this "riddle of the rotting fruit" that captured Janzen's attention twenty-five years ago while he was studying the ecology of Costa Rican plants. It made no sense for plants to waste energy by building pulp that attracted few if any dispersers. Worse, in the case of many fleshy fruits, when the pulp rots, the embedded seeds are killed as well. What was going on here?

In 1982 Dan Janzen, with paleoecologist Paul Martin, published a paper in the journal *Science* titled "Neotropical Anachronisms: The Fruits the Gomphotheres Ate."⁴ Janzen had carried out field studies in Costa Rica to learn whether introduced livestock (horses and cattle) served as surrogate Pleistocene megafauna for the bereft plants. The result: a list of some thirty species of trees and vines of the Costa Rican dry forest whose fruits bear the physical and ecological characteristics of "ecological anachronisms."⁵ These

plants are living in a time warp; they are adapted for a lost world. Their missing animal partners are "the ghosts of evolution."

Anachronisms and ghosts caught the early attention of Robert E. Cook, who is the director of the Arnold Arboretum. Citing Janzen and Martin, Cook published an essay in 1982 in *Natural History* that described the avocado, *Persea americana*, as an ecological anachronism that has been stunningly successful in attracting a replacement dispersal agent: us.⁶ Within the past few hundred years, avocado has been taken from the New World tropics to orchards in Florida, California, northern Mexico, and far beyond this hemisphere. Wild elephants who raid village fruit trees in Africa are now "planting" American avocado on that continent.⁷

In their landmark paper, Dan Janzen and Paul Martin concentrated on Costa Rican plants. But in the final paragraph they extrapolated the anachronism concept to large-fruited plants of



*Strategies of the megafaunal dispersal syndrome. Domesticated varieties of three tropical fruits native to the New World demonstrate a range of pulp attractions and seed defenses. Ripe papaya fruit, *Carica papaya*, is soft enough to mash rather than chew, so the tiny seeds require no physical protection. A mammal that inadvertently crushes a papaya seed is, however, deterred by a sharp, peppery flavor—and thus the toxins so signaled. Primate fruit thieves (like us) can eat around and discard the concentration of seeds, thus foiling the papaya's intent. Avocado, *Persea americana*, produces a slippery and dense seed, whose potent toxins taste bitter to mammals. In contrast, the seeds of the canistel tree, *Pouteria campechinana*, have a mild flavor and are protected instead by a tough coating. All but the biggest frugivores could be expected to eat around or spit the seeds of avocado and canistel.*



Honey locust and her new partner in evolution. Strung along the top are the usual number of seeds in a honey locust pod, such as the one resting on the author's arm.



The most anachronistic legume in North America. The ripe pod of Kentucky coffee tree is toughened by resins, and the seeds are invulnerable to insect attack. The green pulp is sweet but reputedly poisonous to humans. Early colonists in Kentucky roasted and ground the seeds to make a coffeelike brew. The ground "coffee" shown here is courtesy of Carl Mehling.

the eastern and central United States: Kentucky coffee tree (*Gymnocladus dioica*), honey locust (*Gleditsia triacanthos*), pawpaw (*Asimina triloba*), persimmon (*Diospyros virginiana*), and osage orange (*Maclura pomifera*).

To a plant lover, the notion that ghosts may be haunting some of the most magnificent native fruits of one's homeland is a revelation. It was quite a surprise, therefore, when I began the library research four years ago for my book *The Ghosts of Evolution* (2001) to discover that virtually no effort had been made to test these five temperate plants or to identify other possible

anachronisms in the forests and fields of North America. Indeed, scientists currently breeding honey locust trees to increase the fodder value of their pods, and those developing improved pawpaw cultivars and promoting the use of their fruit, have been doing so unaware that the fruits are anachronistic.

Osage Orange—An Extreme Anachronism

Recently, I spoke with an archeologist, Frank Schambach, who felt frustrated because nowhere in the published literature could he find the information he needed to solve the ecological puzzle of osage orange—information crucial for validating his thesis that before settlers began rearranging the landscape, the wood of this tree, highly valued for making hunting bows, may have been traded far and wide in North America under the complete control of a single indigenous tribe.⁸ Schambach suspected that osage orange (also known as bois d'arc, "wood of the bow") occupied a very constricted range that could in fact be claimed by a single tribe.

Osage orange would more appropriately have been named osage breadfruit. A close relative to *Maclura*, of America, and to its sister genus *Cudrania*, of eastern Asia, is the breadfruit genus, *Artocarpus*. All are linked through the mulberry family, a largely tropical family dominated by the figs and striking for its members' compound

fruits and the white latex some exude when cut. Osage orange was named after the Osage Indians of Missouri, who first introduced white traders to this strange fruit—the color of a glow-green tennis ball and about the size and firmness of a softball.

Inhabitants of the plains and prairie states know this fruit by another name: hedge apple. Until the invention of barbed wire in 1874, there was no more effective or economical way to fence free-ranging livestock out of one's vegetable garden or cornfield than to plant a hedge of thorny osage orange stems, later interweav-



An elephant fruit in a land without elephants. The bright green fruit of osage orange was shaped by the now extinct megafauna of North America.

ing the abundant root suckers that the trees send up in response to severe pruning. Thus osage orange gained a replacement dispersal agent, and its range expanded rapidly.

Maclura pomifera, a wind-pollinated tree, is known from pollen samples to have been wide ranging in North America during earlier ice-free phases of Cenozoic history. But by the time of European contact, its range had shrunk considerably: just before its transformation into a common hedge plant, it inhabited only a small stretch of the Red River watershed near the junction of Texas, Oklahoma, and Arkansas. Frank Schambach suspects that at its nadir the range was even more restricted—possibly limited to the Bois d'Arc tributary of the Red River in Texas and nearby creeks of the adjacent Blackland Prairie. Such isolation would explain how a single tribe—the Spiroans of Mississippian culture—could have controlled the entire bow wood trade. And this, in turn, would explain the archeological evidence of extraordinary wealth accumulated by this people in the centuries prior to European contact.

What ecological information did Schambach need to solve his archeological puzzle? He wanted to know whether horses spread osage orange—that is, do horses eat the fruit and defecate viable seeds? If so, then by the time naturalists got around to documenting the geographic reach of osage orange, its renaissance had already been initiated by horses, which had

been reintroduced into North America in the sixteenth century. Surely amateur naturalists and people living wherever osage orange and ranch horses co-exist know the answer to the question—it seems to be yes. But the matter isn't discussed in the published literature. Thus a core contention in Schambach's "Spiroan trader" theory rests on what he has been able to glean from Red River ranchers and his own casual observations.

The search continues. A year after publication of his "Spiroan trader" theory, Schambach obtained crucial anecdotal information: "A volunteer at my dig this summer lives on a ranch on the Blackland Prairie in east Texas,"

Schambach wrote me. "She has a small herd of horses which, she assures me, routinely eat osage orange fruits on their own. Furthermore, she knows for a fact that horses spread the tree via their manure because when she and her husband acquired their property there was no osage orange growing on the upland (prairie) parts of it, only in the bottomlands along the creeks. But soon after they began pasturing horses on the land, the osage orange began to migrate out of the bottoms, and it is now growing all over their prairie areas, to their dismay."

Here's another intriguing story that came my way while I was writing this article—this one from Robert M. Timm, professor of ecology and evolutionary biology at the University of Kansas. Timm has horses and one mule on his farm in Kansas. They all "love the fruits" of osage orange, he wrote me. "The mule is the best at locating them, but if you are experienced with mules that wouldn't be a surprise. They are always much more curious and more exploratory than horses. I'd say of all the natural foods around here, osage orange fruits are the mule's favorite. He seems to remember them from one year to the next, but that too is typical of mules. I have no doubt that Pleistocene horses would have long-term memory of favorite trees to feed at every fall."

Timm is very familiar with Dan Janzen's anachronism theory and has been casually observing mice, rabbits, and tree squirrels feed-

ing on the pulp and seeds. "They don't cache osage orange," he observes, "they eat it on the spot." Most intriguing is his discovery of large quantities of shredded, freshly fallen fruit in the stomachs of deer. All these mammals great and small are indeed eating the fruit, but are they dispersing the seed? Timm concludes no.

Timm acquires buckets of osage orange fruits from neighbors and spreads them on the unpastured sections of his own property as supplemental feed for wildlife. Nevertheless, he has encountered no seedling trees. "I picked up another five gallon bucket of fruits this morning," Timm wrote me as this article went to press, "and I'll check here in a few weeks to see if the seeds make it intact through a mule's digestive tract. I'll pull the mule and horses off the pasture later this month and keep them in a paddock for the winter and give the mule fruits where it will be easy for me to retrieve the seeds."

Overall, anachronism theory seems to be anecdotally well supported for horses as dispersal agents of osage orange. Are there any other plausible ghosts to pair with this native fruit besides Pleistocene horses?

Paul Martin and I had a chance to test osage orange vicariously on a much bigger Pleistocene surrogate: African elephants at the Brookfield Zoo in Chicago. Almost surely this was the first time since the Pleistocene that the fruit of

Maclura pomifera had met the molar of a proboscidean. I sent a box of freshly fallen fruit to Martin, which he in turn forwarded to the Brookfield Zoo. After a search of the literature, zoo staff decided that there was no danger in offering the elephants a few fruits.

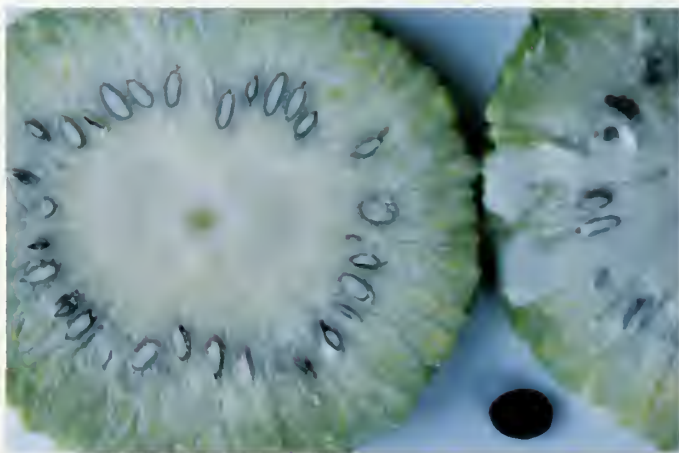
The results were inconclusive. At first, the youngest two elephants didn't want to even touch the fruits offered by their keepers. Finally, each curled a trunk around a sphere and hurled the offensive object out of their habitat. The matriarch, however, chose to sample the first fruit offered, chewing and swallowing. But she would then accept no more.

Herbivores are known to be wary of novel foods. Cultural knowledge of gastronomic possibilities, passed from one generation to the next in social animals, would not be available to zoo elephants. Then too, well-fed captive animals will often turn up their noses at foods that their wild counterparts would happily consume. The case is therefore still to be made that Pleistocene mastodons and mammoths would have joined horses in dispersing osage orange fruits in North America. But it will be a most interesting hypothesis to pursue—for anyone excited by the theory and who has access to elephants!

Powers of Persistence

It is perhaps no coincidence that the five species of temperate American trees judged anachronistic by Dan Janzen and Paul Martin are all prodigious cloners. Vegetative means of reproduction would have helped these trees persist for the thirteen thousand years that sexual reproduction has been disrupted for want of adequate seed dispersal.

Kentucky coffee tree, honey locust, pawpaw, persimmon, and osage orange all send up root suckers—prolifically so when the main stem is pruned or otherwise damaged. Kentucky coffee and pawpaw are extraordinarily skilled in growing lateral root runners that sprout new stems many meters from the elder stem, supported by photosynthates supplied by the parent. Indeed, a few years ago when a pawpaw tree "died" of old age in the Arnold Arboretum, more



An extreme anachronism. Osage orange is one of North America's most anachronistic fruits. Freshly sliced fruit oozes a white latex, which has been wiped clean from the slice on the left. Honey locust seed (1 cm) for scale.

than a hundred fresh stems popped up almost immediately from a vast network of root runners. And although the Arboretum isolates its mature kentucky coffee specimens by encircling the trees with a wide buffer of mowed lawn, grounds staff must periodically rid neighboring beds of the vigorous fresh stems emanating from hidden root runners.

As the ice retreated from its last southward advance, which peaked about twenty thousand years ago, four of the five above-mentioned anachronistic trees of eastern and central North America would have been helped to reclaim former territory by newly arriving humans. Pawpaw and persimmon fruits would have been carried back to camp, their seeds removed or spit out at the time of eating. Honey locust pods would have been opened and licked for their sweet matrix, the hard seeds discarded. Kentucky coffee trees were valued not for their fruit but for their large, nearly spherical seeds, which took a lovely polish and were used for gaming tokens. Although the wood of osage orange was highly prized and known to have been traded across great distances in the time just prior to European contact, the fruits held little if any value. Does this perhaps explain why the range of osage orange became so constricted?

Is the Endangered *Torreya* Tree Anachronistic?

Coming to terms with the likelihood that native horses almost certainly and elephants probably were effective seed dispersers of osage orange during the Pleistocene and for several tens of millions of years before that provides fresh insights into how to rescue from extinction a severely endangered American tree, *Torreya taxifolia* (florida torrey). *Torreya* is a conifer of the plum yew family, Cephalotaxaceae, and thus bears no fruit as botanically defined. Nevertheless, the fleshy design of its diaspore—ecologically a fruit—is an obvious lure for animals. Like a yew or a ginkgo, torrey produces single large seeds enveloped in what ought to be viewed as fruits by vertebrate dispersers.

The proximate cause of *Torreya taxifolia*'s imminent extinction, and thus the cause that gets all the attention, is disease. Some thirty pathogens are known to infest it, but no single

disease seems to be the culprit.⁹ Once common in the rich soils of the Apalachicola River of northern Florida, adult specimens growing in the wild suddenly began to die in the 1950s, and none remain today. Like the American chestnut that was destroyed by (an imported) blight during the early years of the twentieth century, torrey survives only because new stems keep sprouting from the same rootstock. Sadly, each fresh sprout of torrey is doomed to die before it is old enough to produce pollen or ova. Energy stored in the roots will eventually give out, since new starts in the shady forest may consume more photosynthate than they can return to the roots before their demise.

The genus *Torreya* was once distributed throughout the Northern Hemisphere. Range fragmentation has created distinct species in eastern China, patches of the Coast Range and the Sierras of California, and the Apalachicola of Florida. The geographic range of the Florida species is today restricted to the cool ravines along the east side—only the east side—of a 22-mile (35-km) stretch of the Apalachicola River in northern Florida. During the coldest times of the Pleistocene, the Apalachicola, with its moderate climate and rich soils, was a refuge for the trees and forbs that now enrich the Cove Hardwood forest of Great Smoky Mountains National Park, 375 miles (600 km) to the north. After the ice retreated, most of the plants hitched rides from wind and animals and moved back north to their pre-glacial home. *Torreya* seems to have been left behind.

Some experts confirm that the tree's troubles may have begun for want of a disperser.¹⁰ Global or regional extinction of an animal partner (or partners) may be the root cause of the tree's current distress. *Torreya* is probably not ideally suited for the warmth and humidity of today's Apalachicola region. It wants to head north, but it hasn't found a vehicle.

That florida torrey may be haunted by the ghosts of extinct dispersers is suggested by a host of clues. First, the diaspore of all species of *Torreya* is distasteful or toxic to many (possibly all) mammals who normally consume fruits. The pulp has a high terpene content and it leaves a sticky residue on one's skin. Squirrels treat the fruit as they treat ginkgo fruit in New



A florida torrey photographed well north of its "native" grounds, near Philadelphia, Pennsylvania, at the Henry Botanic Garden, near Gladwyne.

York City's parks: they discard the flesh and steal the seeds. Squirrels that fed on torrey seeds on the east side of the river would be unable to carry them across water to the west side, and if the rich soils of the Apalachicola are isolated from rich soils to the north by a barrier of sandy soils, then the squirrels would also be unable to disperse the seeds farther north. Squirrels may thus be a disperser, but they apparently are not the right disperser for helping this tree reclaim its pre-glacial range. This explanation would account for the seemingly paradoxical fact that until the 1950s, florida torrey was the seventh most abundant tree species in an astonishingly small patch of "native" habitat.

Perhaps the best evidence that florida torrey may be suffering from an inability to track climate change is that before the blight took hold, this tree was planted hundreds of miles north of its Florida habitat in the mountains of North Carolina, near Asheville. There, on the Biltmore Estate, the torreyas are thriving, and the females produce abundant seeds. "Flower beds often abound with seedlings 'planted' by squirrels," reports Bill Alexander, landscape historian at the Biltmore. During his 23 years there, Alexander has watched the torreyas stand up well to a five-year drought. And in the winter of 1985 the thermometer plunged to minus-20 degrees Fahrenheit, yet "our trees smiled right through," he told me.

For a number of years, Alexander had been thinking that "florida" torrey really belonged back in North Carolina. So he was delighted to hear of the lost-disperser theory. A megafaunal ghost? If so, the ghost may well be a large extinct tortoise, I suggested, as reptiles are far more tolerant of plant terpenes than are mammals, and as the thin "shell" protecting the large single seed of this conifer offers scant protection against molars.

One must not, however, ponder the plight of the florida torrey in isolation from its sister species. In contrast to *Torrey taxifolia*, California's torrey (*Torrey californica*) is maintaining its population, as are the several Asian species of *Torrey*—all of which bear nearly identical propagules. Nevertheless, all occupy restricted geographic ranges. What if the entire genus lost its key dispersers and now depends on the local activities of squirrels?

Bill Alexander and I easily came up with two plausible explanations for the differences in endangerment, based strictly on geographic differences. In eastern North America, the climatic effects of the Ice Sheet reached much farther south than was the case in either western North America or eastern Asia, forcing the Appalachian species to take refuge at a lower

latitude. Perhaps even more significant is that latitudinal migration was the only option for florida torreyia as the climate warmed. In contrast, torreyia species in California and in Asia could head upslope. These torreyias are native to mountainous regions, where altitudinal gain facilitated by nothing more than squirrels could help the trees keep pace with a warming climate.

Such unsubstantiated and untested leaps of speculation are normally not well received within the scientific community—but these are not normal times. Without some drastic breakthrough in the management of Florida's wild population of torreyia trees, *Torreyia taxifolia* will, within fifty years, almost surely be extinct outside of botanical gardens. Perhaps it is time to help this torreyia gain footholds of wild populations in the mountains of North Carolina.

Such is not, alas, how things are done with endangered species—the exception being the recent return of the california condor to its Pleistocene home near the Grand Canyon. Native territory is regarded as the last best place to be. But what is “native”? How far might we justifiably reach back in time for a benchmark?

In a study of endangered species published in 2000, Rob Channell and Mark Lomolino concluded that “most species examined persist in the periphery of their historical geographic ranges.”¹¹ If habitat at the periphery of historical range is adequate but not ideal, then the last place a troubled species is found may not, in fact, be the best place to assist its recovery.

Transplantation across great distances is an uncommon and controversial technique for biodiversity conservation today. But as the greenhouse effect ratchets up temperatures and reroutes rainfall, and as botanical preserves become even more isolated islands in a sea of human development, long-distance transplantation will become the norm. If gardening a few local patches of endangered plants is tough today, it's going to get a lot tougher when, like it or not, we become gardeners of the planet.¹² Helping plants track climate change from one patch of habitat to another will be a routine tactic for conserving biodiversity decades hence. Is it too early to begin now with florida torreyia?

Notes

- ¹ In the June 8, 2001, issue of *Science*, two papers confirmed the “overkill hypothesis” of end-Pleistocene extinctions, one for Australia and the other for North America. The North American paper is John Alroy, 2001, “A multispecies overkill simulation of the end-Pleistocene megafaunal mass extinction,” 292: 1893–1896. A news report by Leigh Dayton published in the same issue (p. 1819), “Mass extinctions pinned on ice age hunters,” suggests that this view is now the majority position.
- ² Stephen T. Jackson and Chengyu Weng, 1999, “Late Quaternary extinction of a tree species in eastern North America,” *Proceedings of the National Academy of Science* 96: 13847–14852.
- ³ Dan Janzen's suggestion that fleshy-fruited plants may have gone extinct since the end of the Pleistocene is in Connie Barlow, 2001, *The Ghosts of Evolution* (New York: Basic Books), 88.
- ⁴ D. H. Janzen and P. S. Martin, 1982, “Neotropical anachronisms: The fruits the gomphotheres ate,” *Science* 215: 19–27.
- ⁵ For the story of how Janzen and Martin developed their ideas and conducted their fieldwork, see chapters 1–3 of the author's *Ghosts of Evolution*, op cit.
- ⁶ Robert E. Cook, 1982, “Attractions of the flesh,” *Natural History* 91(1): 20–24.
- ⁷ Martin N. Tchamba and Prosper M. Seme, 1993, “Diet and feeding behavior of the forest elephant in the Santchou Reserve, Cameroon,” *African Journal of Ecology* 31: 165–171.
- ⁸ The theory that osage orange, prior to European colonization, occupied a very restricted range is presented in Frank F. Schambach, 2000, “Spiroan traders, the Sanders Site, and the Plains Interaction Sphere,” *Plains Anthropologist* 45: 7–33.
- ⁹ Mark W. Schwartz, Sharon M. Hermann, and Philip J. Van Mantgem, 1999, “Population persistence in Florida *Torreyia*,” *Conservation Biology* 14: 1023–1033.
- ¹⁰ See p. 229 of *The Ghosts of Evolution*.
- ¹¹ Rob Channell and Mark V. Lomolino, 2000, “Dynamic biogeography and conservation of endangered species,” *Nature* 403: 84–86.
- ¹² D. H. Janzen, 1998, “Gardenification of wildland nature and the human footprint,” *Science* 279: 1312–1313.

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Connie Barlow is a science writer and author of *The Ghosts of Evolution: Nonsensical Fruits, Missing Partners, and Other Ecological Anachronisms*, published in 2001 by Basic Books.

Pastures of Plenty: A Case Study in Field Biology

P. L. Marks

Cow pastures are taken for granted in rural parts of the northeastern United States, where they are common. We don't think of them as special habitats, yet they are. Cow pastures have been present in the northeastern landscape since the earliest farm families first carved agricultural lands from the forests. The best land in terms of soil fertility and drainage generally became arable fields, whereas more marginal lands went into pastures. Other marginal lands, often wetter, steeper, or more remote from the main property, were left as forest. But historically, every dairy farm had at least one pasture.

Field biologists work to discover patterns in nature—usually by observation—and then to understand the causal influences behind those patterns. More often than not, the explanations for patterns in nature are complex, a result of multiple factors interacting in various ways over time. Often it is not possible by observation alone to fully understand the cause of a given pattern.

Cow pastures are interesting from a scientific point of view because one factor—the presence of many large, hungry cows—is of overriding importance in determining the abundance and kinds of plants that occur. Whether a pasture began as a natural meadow or as planted forage, the grazing and trampling activities of cows, carried out over years or decades, produce a habitat of closely cropped edible plants interspersed with taller plants that are avoided by the cows due to their physical or chemical properties.

Pastures can be surprisingly beautiful, perhaps because they take on some of the features of landscaped yards and public gardens: large areas of mowed green grass with scattered drifts of taller herbs and small flowering trees—sometimes dramatically pruned into unusual shapes. How does this happen?

In active pastures, the most conspicuous plants are those not eaten by cows. A striking feature of many of these plants is the presence

of thorns or their equivalent. Thistles (*Cirsium* spp.) are common in many pastures. And among woody plants that tend to catch our attention visually, wild or volunteer (not planted) apple trees (*Malus* spp.) and hawthorns (*Crateagus* spp.) stand out. Apple trees do not have true thorns, but their short side branches are sharp at the tips and function as thorns. These distinctive thorny woody plants allow many pastures to be recognized as such as we drive or walk along country roads. Pastures with hawthorns are especially easy to recognize at a distance because the hawthorn bark is light gray and the branches are horizontal in orientation, producing a distinctive growth form. Because they persist for many decades after a pasture is abandoned, the apples and hawthorns also provide a diagnostic legacy of former land use.

We now have a pattern to explain. Why are thorny woody plants so common in cow pastures? An obvious and important first thought is that the thorns prevent or reduce cows' feeding on these plants. This is consistent with other related observations. One is that a variety of non-thorny woody plants invade abandoned pastures, but not pastures where cows are still present. Another observation is that the apples and hawthorns that commonly invade pastures do so when the pastures are active. However, other thorny plants, such as multiflora rose (*Rosa multiflora*), invade a variety of open habitats, not just active pastures.

The implication is that pasture cows are a dominant influence. In their presence thorny plants hold an advantage, whereas on the same land without cows non-thorny plants have the edge. Presumably, plants without thorns cannot invade active pastures because cows eat them. In pastures abandoned for decades one can sometimes see both thorny and non-thorny woody plants. There are dense patches of thorny scrub where plants that started when the pasture was active have grown larger and taller; here few other woody plants have been able to invade.



An active cow pasture in spring, showing cows, closely cropped grass, and a mixture of apple and hawthorn trees. The apple trees range from closely pruned cones to larger trees in flower.

Other areas, where no apples or hawthorns were present at the time of abandonment, now have a variety of non-thorny trees and shrubs such as white ash (*Fraxinus americana*) and gray dogwood (*Cornus racemosa*).

A careful accounting of plant ages should reveal differences between the groups: the thorny plants that invaded when the pasture was active should be ten or more years older than the non-thorny trees that invaded after its abandonment. But inferring plant ages from plant sizes can be misleading. Decades after pasture abandonment, ash trees, which grow faster than apples, will be taller but younger.

Although thorns reduce the feeding pressure from cows, they do not prevent feeding alto-

gether. Indeed, the closely pruned hawthorn and apple plants are perhaps the most spectacular aspects of an active pasture. From a distance, it is difficult to believe these are wild plants, so exquisitely shaped are their crowns. Many look like inverted bowls or cones, whereas others look like old-fashioned hourglass timers. Closer inspection reveals that these geometrical shapes are made up of a proliferation of branches caused by the repeated release of side branches, which, in turn, is caused by cows eating the branch tips year after year. The resulting protective matrix of short, interwoven branches is so dense and rigid that cows can feed only on the plant bits that protrude from it. Conversely, leaves that are near the exterior of the matrix



A typically cone-shaped, closely pruned apple tree, photographed in winter, resides in an active cow pasture. The glove in the foreground provides scale.



The top part of this apple tree, now beyond the reach of hungry cows, shows a spurt of new growth; the tree takes on a characteristic hourglass shape.

but recessed from the edge are protected from cows while still exposed to sunlight. The densely cropped apples and hawthorns and the cows achieve a kind of equilibrium, with the cows unable to penetrate the "shell" and the plants unable to grow beyond it. One of my students proposed the term "bovine bonsai" to describe this lovely piece of pasture horticulture.

The balance between the growth of plants and the cropping by cows sometimes tips in favor of the plants—though just barely. Some thorny woody plants in active pastures expand the volume of their crowns slightly each year, despite

the bovine pruners. Much of this growth occurs in the lower half of the crown so that after twenty or thirty years of modest annual gains plants attain an inverted cone shape. Eventually, this slow lateral expansion reaches a point where cows can no longer reach the tops. This marks an important transition in the lives of these plants. After decades of tortuously slow growth, plants whose tops are beyond the reach of cows suddenly escape much of the bovine influence. Rapid shoot growth begins atop these plants and, in subsequent years, lateral growth increases once it is above the reach of the cows. Eventually a bizarre new growth form is achieved: the shape approximates an hourglass, consisting of a lower inverted cone whose closely cropped outer surface is still maintained by the cows, an upper upright cone that has rapid growth on the inside where the cows cannot reach, and a smoothed lower outer surface where protruding twigs are removed by the cows.

I have walked through a number of pastures, making observations and trying to understand more about the issues discussed above. In active pastures in early spring I have seen seeds from non-thorny trees like white ash scattered within the close cropped turf. Yet seedlings of the same non-thorny species are notably absent, suggesting that the bottleneck for the establishment of these plants is at the seedling stage. In contrast, seedlings of apples and haw-

thorns must at least occasionally become established in pastures in order to account for the larger plants that are so conspicuous later on. Interestingly, hawthorn and apple seedlings lack thorns. Why then can these seedlings survive in active pastures while other non-thorny seedlings cannot? Why doesn't eating and trampling by cows eliminate apple and hawthorn seedlings, as it apparently does the seedlings of non-thorny species? We don't know all the answers, but our understanding of how young plants get started in pastures is more complete for apples than for hawthorns.

Many pastures have apple trees around the edges or a few large, old apple trees within the pasture proper. In autumn, the fruits ripen and cows eat the apples that fall to the ground. The seeds pass through the cow unharmed and are deposited in "cow pies," where they spend the winter. Come spring, these seeds germinate into seedlings that grow directly from the cow pies. The rotting manure provides a locally fertile environment for apple seedlings in cow pastures. In addition, cows typically do not feed on plants growing in or near cow pies. This reprieve from feeding damage, which may last through the first growing season, allows apple seedlings to grow and create energy reserves so that they are more likely to recover the first time they are eaten or trampled upon by cows.

Since not all pastures have apple trees, and since only those cow pies produced when apples are ripe contain seeds, most cow pies do not have apple seedlings. But examining many cow pies in the spring should yield some with apple seedlings, which are recognizable by their two large rounded seed leaves, or cotyledons. One study conducted by Cornell thirty years ago found as many as 250 apple seedlings in a single cow pie!

I once harvested a closely cropped apple tree about five feet (1.5 m) tall in order to estimate its age by counting the annual growth rings on a cross section of the trunk. (Gaining access was not easy—I had to saw a hole in the side of the dense, rigid, sharply tipped branch matrix before I could reach the trunk.) The tree was about thirty years old, which was consistent with the ages reported in the Cornell study. However, even more interesting was the new dimension of pasture ecology it revealed: inside the protective branch shell of this apple tree grew several non-thorny woody plants.

I have since found a number of non-thorny woody species, including white ash, honeysuckle (*Lonicera* spp.), and chokecherry (*Prunus virginiana*), growing inside the protective shell of several apple and hawthorn trees in pastures. These species of trees and shrubs are among the same species that invade abandoned arable fields and pasture. In active pastures, species

intolerant of cattle grazing can generally grow only within the refuge provided by pruned apples and hawthorns.

This essay focuses on cow pastures in central New York State, but the issues raised here apply, to some extent, to cow pastures around the world. Elsewhere there are species equivalent to our hawthorns and apples, such as junipers. There are other kinds of pastures as well, and what is true of cow pastures is not necessarily true of sheep or horse pastures. Both the number of animals and the continuity of the grazing can influence the numbers and kinds of plants that are able to invade. Finally, the function of cow pastures seems to be changing in the Northeast as dairy farming becomes more



Apple seedlings emerging in spring from cow manure deposited the preceding fall.

intensive. Historically, pastures provided forage for dairy cows during the warm parts of the year. On today's large dairy farms, cows may not be pastured at all, and since many dairy cows now receive all their food indoors, cows that are pastured may not crop apples and hawthorns as closely as they did in the past. Even so, evidence of former pastures still remains in the large plants left behind.

Peter L. Marks is a professor in the department of ecology and evolutionary biology at Cornell University.

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HENRY DAVID THOREAU AND THE YANKEE ELM

Thomas J. Campanella

THE American elm (*Ulmus americana*) has always occupied a hallowed place in the pantheon of our native trees, and nowhere was its presence greater than in New England. Planted by the thousands on streets and town commons throughout the region, the elm was a defining symbol of Yankee life. Charles Joseph Latrobe, a Briton who toured New England in the 1830s, summed it up best when he christened the Yankee elm "the glory of New England."¹ Indeed, elms moved pens. Poets to the tree and its beauty abound in the literature of nineteenth-century New England. Hawthorne, Lowell, Longfellow, Holmes, and Henry James all penned eloquent tributes to the tree. So did literary visitors such as Trollope and Dickens.

But no writer who lifted pen to elm did so with more grace and insight than the bearded scribe of Walden Pond. Henry David Thoreau was the poet laureate of the Yankee elm. A prolific writer, Thoreau's pen roved far beyond his celebrated sojourn at Walden. His journals record nearly twenty-five years of observation and bristle with exacting detail. These books map the geography of Thoreau's intellect, a terrain well timbered with elms.

To Thoreau, elms consecrated the landscape. Mircea Eliade has written in *The Sacred and the Profane* that we "found" the world by investing it with religious meaning, and fix sacred space with signs and totems.² In the traditional New England landscape, writes John Stilgoe, meetinghouse spires and church steeples functioned as architectural exclamation points that "made the cellular countryside intelligible to resident and traveler alike."³ Thoreau's leafy steeples were rougher hewn, but they too linked earth and soul. For in Thoreau's church of nature, elms were the beacons of moral and spatial order.

If they rose more leisurely to the sky, once there the elms challenged the lofty white spires themselves. "Some are so lifted up in the horizon," he wrote of elm crowns spied from afar, "that they seem like portions of the earth detached and floating off by themselves into space." Below, Thoreau imagined harmony and spatial order, for where elms brushed the sky, below lay a town or home. "When I see their magnificent domes, miles away in the horizon, over intervening valleys and forests," wrote Thoreau, "they suggest a village, a community, there." Spying the "dark little dome" of a far-off elm, Thoreau was reminded of the "rural and domestic life passing beneath it."

Homestead telegraphs to homestead through these distant elms seen from hill-tops. I fancy I hear the house-dog's bark and lowing of the cows asking admittance to their yard beneath it. The tea-table is spread; the master and mistress and the hired men now have just sat down in their shirtsleeves.

In summer the great canopies cast shelter over house and town, harboring a chorus of insects whose gentle hum induced in Thoreau "contemplation and philosophic thoughts."

The "Washington" elm (a misnomer; see Sheila Connor, *New England Natives*, page 111) on Cambridge Common, Massachusetts, and the "Whitfield" elm on the right, photographed in 1860. From the Archives of the Arnold Arboretum.

But Thoreau's tree was no mere totem of pastoral retreat from the "great world." For him, elms objectified a range of human values. He saw in the elm stoicism, perseverance in the face of adversity. Elms "adjourn not night nor day," he wrote, "they stand for magnificence; they take the brunt of the tempest; they attract the lightning that would smite our roofs, leaving only a few rotten members scattered over the highway." Thoreau was hardly a misanthrope—he attended dinner parties even during his Walden sojourn—but he did favor the company of trees.

When comparing elms with men, however, Thoreau could not help but see the former as more worthy. "I have seen many a collection of stately elms," he confided to his *Journal* in January 1856, "which better deserved to be represented at the General Court than the manikins beneath." Elms may have been set out by villagers, but they towered—literally and figuratively—above mere mortals. "I find that into my idea of the village," he wrote, "has entered more of the elm than of the human being." Indeed, the elms were "worth many a political borough," and certainly more than most politicians.

The poor human representative of his party sent out from beneath their shade will not suggest a tithe of the dignity, the true nobleness and comprehensiveness of view, the sturdiness and independence, and the serene beneficence that [the elms] do. They look from township to township. A fragment of their bark is worth the backs of all the politicians in the union.

Thoreau then extended his metaphor far beyond the environs of Concord. Elms became a medium through which he channeled his outrage over slavery, particularly over the Fugitive Slave Law, which authorized federal agents to return to their owners slaves who had escaped to north of the Mason-Dixon line, and the Kansas-Nebraska Act, which cleared the way for extending slavery into territories not yet granted statehood. Passage in 1854 of the Kansas-Nebraska Act prompted outbreaks of violence across Kansas and drew an impassioned response from Thoreau—"Slavery in Massachusetts"—which he delivered to a convention of abolitionists.⁴

In Thoreau's writings, the Concord elms are a metaphor for the abolition movement, particularly for the Free Soil Party, which had been formed in response to the indecisiveness of the Whigs and Democrats on the expansion of slavery.⁵ In a remarkable passage, Thoreau implores the freedom-lovers to remain true to their principles and to seek equilibrium between old and new, past and progress, conservative and radical. The elms, writes Thoreau, "are free-soilers in their own broad sense."

They send their roots north and south and east and west into many a conservative's Kansas and Carolina, who does not suspect such underground railroads—they improve the subsoil he has never disturbed—and many times their length, if the support of their principles requires it. They battle with the tempests of a century. See what scars they bear, what limbs they lost before we were born! Yet they never adjourn; they steadily vote for their principles, and send their roots further and wider from the *same centre*. They die at their posts, and they leave a tough butt for the choppers to exercise themselves about, and a stump which serves for their monument.

Writing of the relationship between the living sapwood (alburnum) and the dead heartwood (duramen), Thoreau continues to develop his metaphor. The elms "combine a true radicalism with a true conservatism." Yet,

Their radicalism is not cutting away of roots, but an infinite multiplication and extension of them under all surrounding institutions. They take a firmer hold on the earth that they may rise higher into the heavens. Their conservative heartwood, in which no sap longer flows, does not impoverish their growth, but is a firm column to support it; and when their expanding trunks no longer require it, it utterly decays. Their conservatism is a dead but solid heart-wood, which is the pivot and firm column of support to all this growth, appropriating nothing to itself, but forever by its support assisting to extend the area of their radicalism. Half a century after they are dead at the core, they are preserved by radical reforms. They do not, like men, from radicals turn conservative. Their conservative part dies out first; their radical and growing part survives.

In the end the elms (and Free Soilers) will "acquire new States and Territories, while the old dominions"—the slaveholding South—"decay, and become the habitation of bears and owls and coons."

On most days, however, the elms of Concord were simply Thoreau's companions, soul mates he loved and mourned. In January of 1856 Thoreau witnessed the felling of a great elm. The tree, which measured more than fifteen feet in circumference, had made creaking noises in a recent storm, frightening neighboring homeowners into believing that the great mass of wood was about to crash onto their roofs. For Thoreau, the destruction of this tree represented the slaughter of a priceless witness to the history of the community.

"I have attended the felling," he wrote in his *Journal*, "and, so to speak, the funeral of this old citizen of the town . . . I have not known a fitter occasion for a sermon of late." Having "taken the measure of his grandeur," Thoreau spoke "a few words of eulogy at his grave, remembering the maxim *de mortuis nil nisi bonum* (in this case *magnum*)" [speak nothing but good of the dead (in this case *the best*)]. But only the woodchoppers and passersby heard his words. The shattered tree had hardly come to rest than the "axe-boys had climbed upon it like ants" and begun hacking at its limbs. "How have the mighty fallen!" eulogized Thoreau, "Methinks its fall marks an epoch in the history of the town."

How much of old Concord falls with it! The town clerk will not chronicle its fall. I will, for it is of greater moment to the town than that of many a human inhabitant would be. Instead of erecting a monument to it, we take all possible pains to obliterate its stump, the only monument of a tree which is commonly allowed to stand. How much of old Concord was cut away with it! A few such elms would alone constitute a township. They might claim to send a representative to the General Court to look after their interests, if a fit one could be found, a native American one in a true and worthy sense, with catholic principles.

"Our town," concluded Thoreau, "has lost one of its venerables." The woodcutters "have laid the axe . . . to one of the king-posts of the town." "Is it not sacrilege," he asked, "to cut down the tree which has so long looked over Concord beneficently?"

Once the tree had been felled, its great size awed even Thoreau. His fellow Concordians seemed oblivious to the glory of the living elm and would not appreciate this magnificent specimen of plant life until it lay prostrate on the earth. At a dinner party shortly before the woodchoppers laid low the tree, he tried to convey the sense of wonder that the behemoth stirred in him. "I surprised some the other day," he wrote in his journal, recounting the incident, "by saying that when its trunk should lie pros-

trate it would be higher than the head of the tallest man in the town, and that two such trunks could not stand in the chamber we were then in, which was fifteen feet across; that there would be ample room for a double bedstead on the trunk, nay, that the very dinner-table we were sitting at, with our whole party of seven, chairs and all, around it, might be set there."

Just as he had plumbed the depths of Walden Pond, Thoreau recorded the girths of the elms of Concord.⁶ These records were for him "the quantitative expression of his immersion in Nature," writes Alfred Kazin, "proof positive that he touched Nature on every side."⁷ In the winter of 1846, Thoreau had measured the waters of Walden Pond, in part to prove that local wisdom regarding its depth was utterly in error. "It is remarkable how long men will believe in the bottomlessness of a pond," he wrote, "without taking the trouble to sound it."⁸

With its annual rings exposed by the axe, the trunk of the great elm offered a precise record of the tree's journey in time. Yet it seems that only Thoreau possessed the imagination to count them. "Men have been talking now for a week at the post office about the age of the great elm," he wrote, "as a matter interesting but impossible to be determined." Even the very men who felled the tree "stood upon its prostrate trunk and speculated upon its age, as if it were a profound mystery." He endeavored to show them that in fact there was no mystery at all, but his words fell on deaf ears.

By Thoreau's measure, the elm had lived 127 years, but no one took seriously his method or his result. Some villagers insisted that the tree was 200 years old; one maintained it was closer to 150 years, having spent 50 years growing, another 50 standing still, and a final 50 dying. ("Wonder what portion of his career he stood still!" Thoreau wrote.) As with the storied depths of Walden Pond, Thoreau was incredulous that men would choose to remain ignorant when the truth lay within easy reach, requiring but a simple act of measurement to bring forth. "Truly they love darkness rather than light," he wrote in his *Journal*.

They dwell within an integument of prejudice thicker than the bark of the cork-tree, but it is valuable chiefly to stop bottles with. Tied to their buoyant prejudices, they keep themselves afloat when honest swimmers sink.

Mary Emerson alone offered this rational poet a measure of consolation: "It was not the fashion to be so original when I was young," she told Thoreau, before agreeing that indeed the fallen elm had revealed its truths only to him.

The autumnal elm, with its "early and golden maturity," made a particularly strong impression on the Concord naturalist. "It would be worth the while," he wrote in *Autumnal Tints*, "to set out these trees, if only for their autumnal value."

Think of these great yellow canopies or parasols held over our heads and houses by the mile together, making the village all one and compact—an *ulmarium*, which is at the same time a nursery of men! And then how gently and unobserved they drop their burden and let in the sun when it is wanted, their leaves not heard when they fall on our roofs and in our streets; and thus the village parasol is shut up and put away!

Thoreau saw autumn as symbolic of the glorious destiny he predicted for the United States. It was an appropriate metaphor, for the vibrant colors of the northern deciduous forests rank among North America's greatest natural wonders. The seasons of human progress had brought the American to these autumnal shores, where a rich bounty would be harvested as its people grew in wisdom and maturity.⁹

The great fall of elm leaves in October transformed Concord into "a scene of a great harvest-home," its paths and walks strewn with the summer's spent array. In their form and color, the great yellow masses reminded Thoreau of sheaves of wheat; it was "as if the harvest had indeed come to the village itself." Now, he suggested, "we might expect to find some maturity and *flavor* in the thoughts of the villagers at last." Would there be, he wondered, an "answering ripeness" in the lives of the men who lived beneath these glorious domes. He found it untenable that such beauty could accompany mean and illiberal thoughts. "Under those bright rustling yellow piles . . ." wrote Thoreau, "how can any crudity or greenness of thought or act prevail?" As he watched a farmer disappear beneath the village elms, his wagon creaking beneath the fruits of his summer, Thoreau was tempted to follow the man to the granary, perchance to witness a "husking of thoughts, now dry and ripe, and ready to be separated from their integuments . . ." But he turned away, knowing it would be "chiefly husks and little thought . . . for, as you sow, so shall you reap."

For all his seriousness of purpose, Thoreau never lost his playful, rhapsodic voice. Standing beneath a cluster of October elms, "warm from their September oven," he imagined that he stood "within a ripe pumpkin-rind"; "I feel as mellow as if I were the pulp," he quipped, "though I may be somewhat stringy and seedy withal." For this man, walking beneath the October elms of Concord was itself a harvest—of seeds and thoughts he had sown himself—and which many generations would reap.

NOTES

Unless otherwise noted, quotations from Henry David Thoreau can be found in the Riverside editions of *The Journals of Henry David Thoreau*, VIII (Nov. 1, 1855–Aug. 15, 1856): 117, 130–132; 139–142; X (Aug. 8, 1857–June 29, 1858): 89 (edited by Bradford Torrey and Francis H. Allen, Boston: Houghton Mifflin, 1906); and "Autumnal Tints" in *Excursions* (Houghton Mifflin, 1883), pages 233–234.

¹ Charles Joseph Latrobe, *The Rambler in North America*, vol. 1 (New York: Harper & Brothers, 1835), 43–44.

² Mircea Eliade, *The Sacred and the Profane* (New York: Harcourt Brace, 1959), 20–31.

³ John R. Stilgoe, *Common Landscape of America* (New Haven: Yale University Press, 1982), 57.

⁴ William Howarth, ed. *Walden and Other Writings* (New York: Modern Library, 1981), xxiv.

⁵ Robert L. Gale, *A Cultural Encyclopedia of the 1850s in America* (London: Greenwood Press, 1993), 139–140. The Free Soilers, established in 1848, "adopted a platform with three main planks: no slavery in the territories, no slavery in any new state, and free homesteading rights for public domain settlers. The spirited slogan of the new party—'Free Soil, Free Speech, Free Labor, Free Men'—gave the party its name."

⁶ Thoreau made the following entry on 23 January, 1856: "Holbrook's elm measured to-day 11 feet 4

inches in circumference at six feet from ground, the size of one of the branches of the Davis elm . . . Cheney's largest in front of Mr. Frost's, 12 feet 4 inches, at six feet; 16 feet 6 inches, at one foot. The great elm opposite Keyes's land, near by (call it the Jone's elm): 17 feet 6 inches, at two behind and one plus before; 15 feet 10 inches, at four; 15 feet 5 inches, at six; 16 feet at seven and a half, or spike on west side. At the smallest place between the ground and branches, this is a little bigger than the Davis elm, but it is not so big at or near the ground, nor is it so high to the branching . . . nor are the branches so big, but it is much sounder, and its top broader, fuller, and handsomer." See Thoreau, *Journal*, 135–136.

⁷ Alfred Kazin, *A Writer's America: Landscape in Literature* (New York: Alfred A. Knopf, 1988), 61.

⁸ Henry David Thoreau, "The Pond in Winter," in *Walden and Other Writings*, William Howarth, ed. (New York: Modern Library, 1981), 256.

⁹ William Howarth, xxvii.

Thomas J. Campanella is an urbanist and historian. His books include *Cities from the Sky* (Princeton Architectural Press, 2001) and *Republic of Shade* (Yale University Press, forthcoming). He teaches in the department of urban studies and planning at MIT, and is a Mercer Fellow at the Arnold Arboretum.

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The Arnold Arboretum

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Projects, Programs, and Research: Planning for the Future

Robert E. Cook, Director

Rising out of the ground below the Dana Greenhouses is a visible harbinger of change at the Arnold Arboretum. On a sloping, three-acre site, massive fieldstone walls that were constructed over the summer have formed a series of terraces to hold a new collection of sun-loving shrubs and vines. Soon a steel-framed, wood-covered pavilion will be erected to provide a shady resting place overlooking the collection beds and the great lawn that runs down the center of the garden. This project is one of several major landscape improvements that will be completed over the next two years.

These physical transformations will be accompanied by other significant changes in the programs and operations of the Arboretum. New goals, consistent with our traditional mission of research and education, are emerging from the long-range planning process that have engaged the staff over the past ten months. One goal will include a renewed commitment to improve the physical setting and, therefore, the image of the Arboretum in the eyes of the public. The shrub and vine garden described above will set a new standard of excellence to be followed in renewing the older parts of the grounds—the gates and walls, the benches and pathways, location and directional signage.

We are also contemplating a significant expansion of the

Arboretum's public and professional education programs. The Radcliffe Institute (formerly Radcliffe College) has approached us about the possibility of merging their programs in landscape design and landscape design history with our existing adult education programs. Through a series of rigorous courses and studios, the Radcliffe programs have for 35 years offered part-time and continuing education students a curriculum that leads to a certificate in landscape design and landscape design history. Providing a home at the Arboretum for the programs would greatly enhance our educational activities.

Finally, the planning process has revealed significant dissatisfaction with the future prospects for scholarly work at the Arboretum, which currently includes research on the living collections in Jamaica Plain, herbarium and library research in Cambridge, and research conducted in foreign settings such as the tropical forests of Southeast Asia. It is unclear that the existing criteria for research appointments and the related support systems truly serves the long-term interest and international reputation of the institution.

Alternative configurations of the research model are not easy to envision because of the complicated relations between the Arboretum and academic units at Harvard. At the very least, the

long-range plan will include a call for change in the model and an outline of the benefits that such a change might bring to our programs of research and education on woody plants around the world.

Mary Gibson Henry Medal Honors Carroll Wood



Stuart Watson

Carroll E. Wood, Jr., professor of biology emeritus at Harvard University, is among the first recipients of the Mary Gibson Henry Medal, presented on September 7 at the Henry Botanic Garden in Gladwyne, Pennsylvania.

Dr. Wood has enjoyed a long association with Harvard Univer-

• continued on page 2

sity and the Arnold Arboretum. He received a master of arts from Harvard in 1947 and a doctorate in 1949. After serving as a biology instructor for the Faculty of Arts and Sciences from 1949 to 1951, Dr. Wood became an associate curator for the Arboretum in 1954 and a curator in 1970, a position he held until his retirement in 1988. He lectured on taxonomy at Harvard between 1964 and 1972, when he was named a professor of biology. Dr. Wood continues to focus his energies on the completion of his *Generic Flora of the Southeastern United States*. Since its beginning in 1954, 162 papers of this prodigious work have been published, both in the *Journal of the*

Arnold Arboretum and the *Harvard Papers in Botany*.

While a student at the University of Pennsylvania in 1942, Dr. Wood became acquainted with Mary Gibson Henry during a collecting trip for the University's *Flora of Pennsylvania*. Their common interest in native plants kept them in contact over the years, beginning with a gift of Arizona yuccas and cacti he sent to Mrs. Henry during the war years. Later, he provided scientific support for some of her plant discoveries, including writing the Latin description for *Lilium iridollae*, the pot-of-gold lily. (See Mary Harrison's article "Mary Gibson Henry, Plantswoman Extraordinaire" in *Arnoldia*, vol 60, no.1.) Around the time of Mrs. Henry's

death in 1967, Dr. Wood became a member of the Board of the Henry Foundation for Botanical Research and has been instrumental in the acquisition of additional land and of nonprofit status for the Foundation's gardens.

The Henry Botanic Garden honored Dr. Wood and three other medal recipients with a ceremony and reception at the Henry Foundation for Botanical Research, where, on 50 acres, a wide variety of plants grow in naturalistic woodland and hillside settings and research gardens promote genetic diversity. Dr. Wood, who contributed wild-collected plant material to the garden's collections, was cited for his "extraordinary contributions to botanical research."

Albert J. Fordham, 1911–2000

Al Fordham, who retired in 1976 as head propagator and research horticulturist of the Arnold Arboretum, passed away last December at the age of 89 in Norwood, Massachusetts. He had been affiliated with the Arboretum for nearly 50 years. Al will be remembered for his many contributions to horticulture, including the many new cultivars of dwarf conifers he developed and his work on woody plant seed germination.

Al began his career at the Arboretum in 1929 as a student intern to propagator William H. Judd. In 1936 he spent a year studying European horticultural practices at the Royal Botanic Garden in Kew. After three years of service in the U.S. Army Infantry during World War II, Al returned to the Arboretum as assistant superintendent of grounds. From 1958 to 1976, he was the sole plant propagator at Harvard University, and it was during this period that the propagation department of the Arboretum was reorganized and the Dana Greenhouses were designed and built.

Al's work was distinguished by a willingness to test new methods of propagation and by his fastidious recording of experimental results. In addition to teaching and lecturing extensively on propagation, he published more than 100 research papers between 1958 and 1975, many in the pages of this magazine. His research topics included the barriers that hinder



Photograph courtesy of the Arnold Arboretum Photographic Archives.

germination of woody plant seeds, the role of physiological juvenility in plant propagation, and methods of seed dispersal. He also studied microclimates as they relate to plant survival.

In 1963 Al began collecting and experimenting with seed from witches' brooms, which resulted in the introduction of several new cultivars of *Pinus banksiana*, *P. strobus*, and *P. resinosa*. He gave his cultivars native American names such as "Merrimack,"

• • continued on page 3

IMLS Grant Integrates Past and Present Collections

The Arnold Arboretum was recently awarded a \$49,000 conservation support grant from the federal government's Institute of Museum and Library Services in Washington, D.C. As outlined in the proposal, written by Jianhua Li and Peter Del Tredici, the grant will be used to finish integrating data from the Arboretum's herbarium specimens into the living collections database (BG-Base).

The project will proceed in three interrelated steps. The first is to enter information into the database from each sheet (voucher) of specimens that have been collected on the Arnold Arboretum's grounds. The staff will then be able to generate a list of plants that have not been vouchered or whose specimens do not include diagnostic structures (mostly flowers and fruits), leading to the second step: specimen collection, preparation, and data entry for those plants. In the third step, data will be entered for existing herbarium specimens representing plants no longer growing on the grounds.

At its most basic level, the project will allow the staff to learn which plants now growing on the grounds are not adequately represented by specimens in the herbarium. In addition, it will expand the database to include not only plants currently living on the grounds, but also those that have ever grown here and are represented by an herbarium specimen. Our services to botanical and horticultural communities at home and abroad will also be enhanced since the database will be one of the most comprehensive voucher systems for large living collections in the world, a crucial component of meaningful scientific



Botanical drawing of *Salisburia adiantifolia* (*Ginkgo biloba*) from Siebold and Zuccarini's *Flora Japonica*, courtesy of the Arnold Arboretum Library.

research. The Arboretum staff have been working slowly and deliberately to achieve this goal for over ten years, but the IMLS grant will allow us to incorporate the last 24,000 herbarium specimens into the living collections database in timely fashion.

The project team, to be coordinated by Jianhua Li, will include Kyle Port, Susan Kelley, Irina Kadis, and Sara Straate.

● ● from page 2

"Chippewa," and "Neponset" in recognition of New England's tribal heritage. In 1985 Al himself was recognized for his pioneering work with conifers by the naming of *Pinus parviflora* 'Al Fordham'.

Over the years, Al was honored for his achievements by a number of amateur and professional organizations. He was an honorary member of the Massachusetts Horticultural Society, which awarded him its Jackson Dawson Medal in 1965. Other honors included awards of merit from the International Plant Propagators Society (1971), from the International Lilac Society (1973), and the American Conifer Society (2000). He also received a professional citation and certificate of appreciation from the American Horticultural Society.

In 1976 Al retired from his Arboretum duties but continued his horticultural research as well as writing, lecturing, and consulting. Among other post-retirement achievements, he published the *Arnoldia Manual of Propagation of Selected Conifers* in 1977 as a separate issue of this magazine.

Al Fordham's expertise and his insatiable curiosity about all aspects of plant development proved a timely fit for an institution that required a master propagator and a steady stream of new material for its living collections. Through his published work, his classes, and his lectures, he taught a generation of New England gardeners about plant propagation and left a legacy to horticulturists throughout the world.



Summer Interns

The 2001 Summer Interns in the Arboretum's largest white oak (*Quercus alba*), from left to right: John Backer, Rose Morgan, Sarah Carter, Sara Straate, Dan March, Bethany Knorr, Emma Stark Schiffman, Kim Rennick, Steve Egger, Nicole Napoleon, Marissa Farris, Whitney O'Hanian. Not pictured: Jean Gauthier.

Tides Foundation to Receive Plant Sale Donation

The Tides Foundation's 9/11 Fund will receive \$5,000 from the Arnold Arboretum to support relief efforts for the events of September 11. Director Robert E. Cook announced at the annual fall plant sale that proceeds from the live auction would be donated to assist those immediately affected by the tragedy, and that a *Quercus coccinea* (scarlet oak) would be planted on Peters Hill to commemorate the victims. The Tides Foundation was chosen by Arboretum staff as the recipient of the Arboretum's gift.

The Tides 9/11 Fund was established to meet immediate and long-term needs in the wake of

September 11 and to promote a just and peaceful national response to this crisis. As of October 22, over \$335,000 had been raised for this fund, and \$215,000 in grants had been allocated to 18 organizations. In crafting their grant-making strategy, the Tides Foundation has worked to blend their core values of social and economic justice with the pressing needs created in the aftermath of the attacks.

For more information about this fund or for a complete list of grantees, contact the Foundation at info@tides.org.

The James Arnold Society

The Arnold Arboretum is proud to announce the formation of the James Arnold Society, named for the benefactor whose bequest made possible the Arboretum we value so much today. This new society will recognize those who have made life income gifts or bequest provisions for the Arnold Arboretum. If you have included the Arboretum in your long-term charitable plans, we would like to welcome you into this special group.

Members of the James Arnold Society will be invited to events at the Arboretum and receive a complimentary invitation to any one of the Harvard University-sponsored financial and estate-planning seminars.

Please contact Anne McClintock or Amy Goldman of University Planned Giving at 800.446.1277 or pgo@harvard.edu to discuss your current gift arrangements or to explore ways to benefit the Arboretum through a life income gift or bequest. Your inquiry will be held in the strictest confidence.

For more information, please visit www.haa.harvard.edu/pgo.





GRAY HERBARIUM

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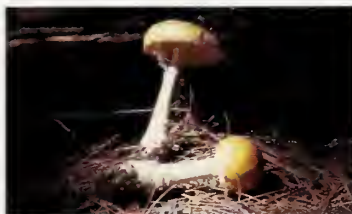
Covers: Nearly 90 percent of all plant species enter symbiotic associations with mycorrhizal fungi: the more extreme the conditions, the more interdependent the two organisms. The plants shown in the four cover photographs, all growing under highly stressful conditions, undoubtedly rely on mycorrhizal fungi for their survival. Photographs by Peter Del Tredici.

Front: *Pinus ponderosa* in Bryce Canyon National Park, Utah.

Inside front: Bearberry (*Arctostaphylos uva-ursi*) on Cape Cod National Seashore, Massachusetts.

Inside back: Lowbush blueberry (*Vaccinium angustifolium*) near the summit of Mt. Monadnock, New Hampshire.

Back: *Pinus longaeva* (bristlecone pine) in Bryce Canyon National Park, Utah.



GEORGE W. HUDLER

Nexus of the Underground: A Tale of Mycorrhizae

David W. Wolfe

"In the days when the 'information superhighway' is the buzz phrase, we would do well to look at our inventive fungal predecessors who, for four hundred million years, have already been leading the communication network of life on land."—Lynn Margulis (1994), in the Foreword to *Hypersea* by Mark and Dianna McMenamin

Over the centuries, naturalists and poets have often attempted to describe their intuitive sense of a "connection" between living things. Science is now revealing how very real and intimate some of these connections are. In many of our forests, grasslands, and other natural ecosystems, if it were possible to gaze down and witness all that is below, one of the most striking things we would see is the vast network of gossamer-like fungal threads linking the roots of plants of different species. We have only recently learned that the expansion of life up and out of both the sea and the deep Earth was founded on this very important symbiosis between plant and soil fungus. It has been just as fundamental to the evolution of life on our planet as the relationship between nitrogen-fixing bacteria and legume plants. The roots of almost all plant species in the world today are joined with these specialized fungi that help them obtain water and nutrients from the soil (and sometimes from neighboring plants), in exchange for the carbon- and energy-rich sugars produced by the plant during photosynthesis. It's a connection that began long ago, when life on the land surface was just getting started.

The colonization of Earth's land surface did not begin in earnest until the early Devonian period, a little over 400 million years ago. This land invasion was more than three billion years in the making, during which time the subterranean creatures that would be required to support surface life had become established.

The first photosynthetic organisms to attempt life on land came ashore from marine environments as rootless, green algae-like creatures. Needless to say, these sea dwellers were in for quite a shock when they tried their luck on land. Most quickly shriveled up and died. Over the course of millions of years, however, some managed to survive by being the first to establish a successful partnership with soil fungi. The fungi functioned as surrogate roots, supplying their algal partners with water and nutrients mined from the underground, while the algae collected solar energy at the surface and supplied the fungi with the products of photosynthesis.

The descendants of those first photosynthetic species gradually evolved into primitive plants with roots of their own. The symbiosis with fungi did not end, however. Today, more than 400 million years after the first tentative union between alga and fungus, you are likely to find descendants of those beneficial fungi growing on almost any plant you yank up by the roots, regardless of where on Earth you might be. In many cases you would need to use a microscope and special staining procedures to spot the delicate fragments of threadlike hyphae dangling from the roots, but they would be there. These fungi-root associations are referred to as "mycorrhizae" (from the Greek, *mykos* = fungi, *rhiza* = root). More than 90 percent of the approximate 230,000 species of vascular plants on our planet today have found it advantageous to continue this mutually beneficial partnership. In fact, the



GEORGE W. HUDLER, CORNELL UNIVERSITY

The aboveground fruiting bodies—or mushrooms—of the genus *Amanita*, common types of ectomycorrhizal fungi.



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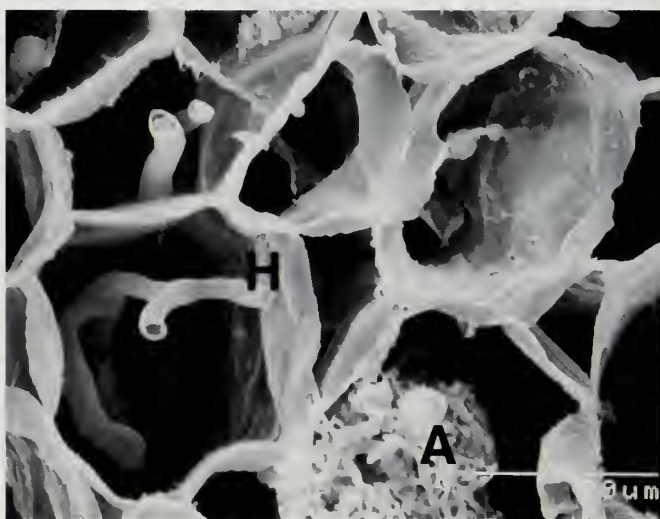
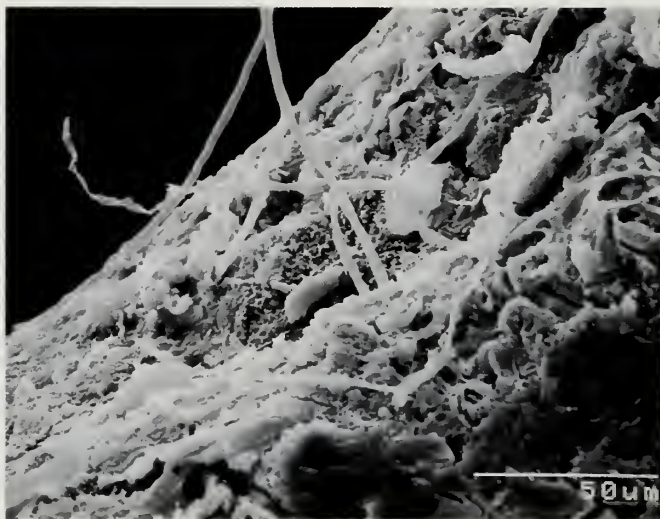
Many fungi in the *Boletus* genus are ectomycorrhizal, forming a mutually beneficial partnership with plants in which the plants provide the fungi with the products of photosynthesis (carbon-rich sugars) while the fungi help the plants acquire water and nutrients.

majority of these plant species could not survive in nature without it.

Many of the mycorrhizal fungi are just as dependent on their plant partners as the plants are on them. We are unable to culture some of the most common types in the laboratory, even with our most sophisticated concoctions of sugars and nutrients. Scientists have speculated that these fungi depend on plants not only for a share of the products of photosynthesis, but also for some as yet unidentified essential growth hormones.

The fossil record confirms that the first mycorrhizal fungi evolved at just about the same time as land plants. Viewed through a micro-

scope, one can see their unique hyphal branching structures, resembling miniature tree shapes, that form just within the root tissues. These structures, called "arbuscles" (from the Latin, *arbor* = tree), are the interface for exchange of nutrients with the plant host. In 1994, fossils from an important archaeological site called the Rhynie Chert, near Aberdeen, Scotland, were re-examined and found to contain evidence of arbuscles. The rocky layers in which these fossils were discovered are just over 400 million years old, from the early Devonian period. Along with the fungi, fossil evidence of primitive, pioneer land plants was also found.



Genetic analyses have provided additional evidence of the long history of this symbiosis. In the early 1990s, the first sequencing and evolutionary classification of ribosomal DNA collected from arbuscular mycorrhizal fungi confirmed that they originated between 350 to 460 million years ago, coincident with the estimated time of origin of the first land plants. Today, arbuscular mycorrhizae are found almost everywhere except in some arctic regions, and the list of plant species involved as hosts is a very long one. Most temperate and tropical nonwoody plants, such as grasses, wildflowers, and our most important crop plants are host to this type of mycorrhizae, as well as woody perennials such as azalea, apple, grape, cedar, maple, ash, and many tropical trees. We have not yet found a single arbuscular mycorrhizal fungus that grows independently of a plant host.

The fossil record as well as other DNA studies reveal that a second major group of mycorrhizal fungi, called "ectomycorrhizae," evolved about 160 million years ago. The ectomycorrhizae are unique in that they do not form arbuscles inside the root tissues, and their silken hyphal filaments extend out farther from the roots (often several yards) compared to arbuscular mycorrhizae. The ectomycorrhizal fungi release a plant hormone that causes the growth of short, stubby, branching rootlets here and there along the main roots of the plants they

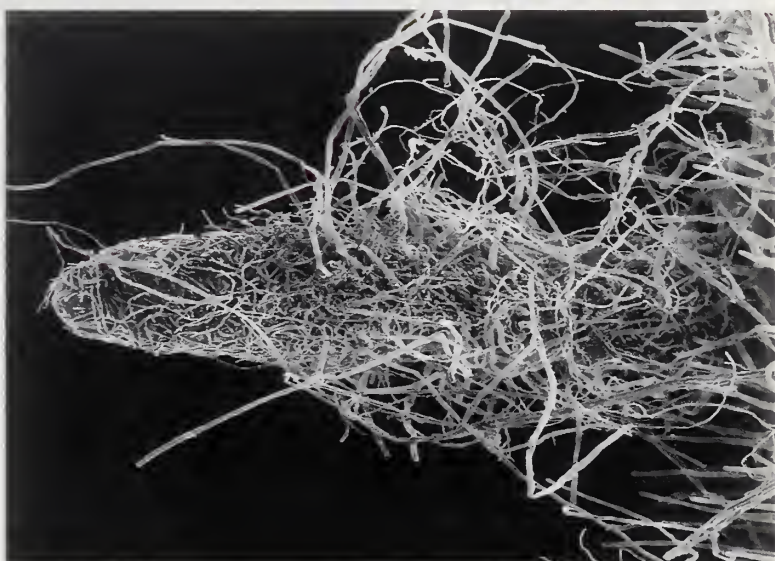
The scanning electron micrograph at top shows an arbuscular mycorrhizal fungus (Glomus intraradices) on the surface of a root from a grapefruit plant (Citrus paradisi). Penetration of the threadlike hyphae (H) and arbuscles (A) into the root cells is shown at center. At bottom, note the points where the hyphae branch and penetrate between rhizodermic cells. In this symbiosis, the fungus helps the plant roots gather water and nutrients from the soil or adjacent plants, and the plant provides the fungus with carbon and energy captured via photosynthesis.

inhabit. These characteristic multi-branched rootlets are about one-eighth of an inch long (about three millimeters), so can usually be identified in the field without the aid of a microscope. The mycorrhizal roots are composed of a central core of plant tissue, completely encased by a dense mat of fungal hyphae. The ectomycorrhizae are particularly important in many temperate and arctic forests. They form symbioses that are crucial to many economically important timber trees such as pine and other conifers, oak, beech, chestnut, and birch. Their list of plant hosts is not as long as the more ancient arbuscular mycorrhizae, but they have a wide geographic range and are found growing with woody perennials and even a few nonwoody species from the tropics to the arctic.

There is a great deal of overlap between the ectomycorrhizae and the more ancient arbuscular mycorrhizae with regard to their geographic range and plant hosts. Both types of root fungi can often be found in the same forest, meadow, or crop field, and even growing on the same plant. Maples and poplar trees, for example, are sometimes simultaneously a host to representatives of both major groups of mycorrhizal fungi.

The mycorrhizal fungi are so common and abundant in nature that it is very difficult to find or create an environment without them. Those doing research with mycorrhizae have sometimes found it necessary to not only sterilize the soil to create a "no mycorrhizae" control treatment, but they also must filter the air entering the greenhouse to prevent free-floating volunteer spores of mycorrhizae from contaminating their experiments.

The discovery of mycorrhizae was, as is often the case, serendipitous. The road to discovery began in the early 1880s, when the king of



At top, ectomycorrhizae on pine with the characteristic shortened, thick roots covered by fungal hyphae; and at bottom, a magnified view of the thick hyphal mat surrounding a modified root hair.

Prussia commissioned one of the world's leading forest biologists, Professor A. B. Frank of the Landwirtschaftlichen Hochschule in Berlin, to study, of all things, truffles. These highly prized delicacies are the belowground fruiting (spore-forming) body of a rare type of aromatic fungus (*Tuber melanosporum* and *T. magnatum* species) found in some hardwood forests of western Europe. Then, as now, truffles sold at incredibly high prices because of their rarity and their unique aroma and delicate flavor. The hope of

the Prussian government was that Frank would develop a way to produce truffles on a commercial scale, like the common (and much less expensive) grocery store mushroom, which is the aboveground fruiting body of another type of fungus (*Agaricus brunnescens*).

Professor Frank failed rather miserably at coming up with a commercial method for cultivation of truffles. (Incidentally, so have all others who followed him, which is why, if I wanted to buy a pound of truffles today, I would have to be willing to pay close to one thousand dollars per pound!) There are two edible species—black (*Tuber melanosporum*), native to Germany, France, and Spain, and white (*T. magnatum*), found in northern Italy. Both types are still extremely rare. They have been sought after for their culinary qualities since Roman times. The black “Perigord” truffle is reported to have been hunted down in fifteenth-century France with the use of trained, muzzled pigs that could sniff out the smelly fungi. The highly competitive “truffle hunters” of today, or “truffiers” as they are called in France, roam their secret forest haunts with trained dogs instead of pigs, but little else has changed. Humans and their trained animals aren’t the only truffle hunters—voles and other rodents seek them out by smell, and spread the spores as they take the truffles back to their underground burrows.

What Frank did discover launched a century’s worth of research, the results of which we are only now beginning to fully appreciate. “We should all fail so nobly,” as Michael Allen, one of today’s leading mycorrhizal researchers put it. Frank was a meticulous and very observant scientist, and fairly quickly came to realize that truffles were never found growing independently, but were always in the vicinity of oaks, filberts, and certain other forest trees. At first he suspected the truffles of being weak parasites, but eventually, through well-designed and care-



Chanterelles (shown above) and truffles have a unique and delightful flavor prized by gourmets around the world. They also play an important ecological role: the belowground hyphae of these mycorrhizal fungi attach to the roots of nearby plants and assist the plants in mining the soil for water and nutrients.

fully conducted experiments, he was able to prove that the belowground hyphae of the truffles formed a very important mutually beneficial symbiosis with the roots of the trees they inhabited. It was Frank who coined the term “mycorrhizae” to describe this fungus-root partnership in a classic paper published in 1885. In his own words, he concluded that the mycorrhiza “functions in a nutritional capacity as a wet nurse of the tree.”

Although Professor Frank is given credit for the discovery of mycorrhizae, scientific historians have found that others had studied other kinds of mycorrhizae before him. Frank was aware of this earlier work, and it undoubtedly laid the groundwork for his more conclusive experiments. In the mid 1800s scientists had identified a fungus growing on the roots of small nongreen plants in the genus *Monotropa*, and another type associated with orchids, both of which we now know to be mycorrhizal. Several of these researchers suspected some type of reciprocal relationship between the fungi and their plant hosts, but their experiments were inconclusive, and the subject remained controversial until Frank came along. In addition to studying truffles, Frank also spent a great deal of



Some of the first mycorrhizal fungi were discovered growing on the roots of plants in the genus *Monotropa* (also known as Indian pipes). These plants lack chlorophyll and a well-developed root system. They rely on their belowground partners not only for water and nutrients, but also for carbon-rich sugars that the fungus obtains by tapping into the root systems of adjacent trees or other photosynthetic plants.

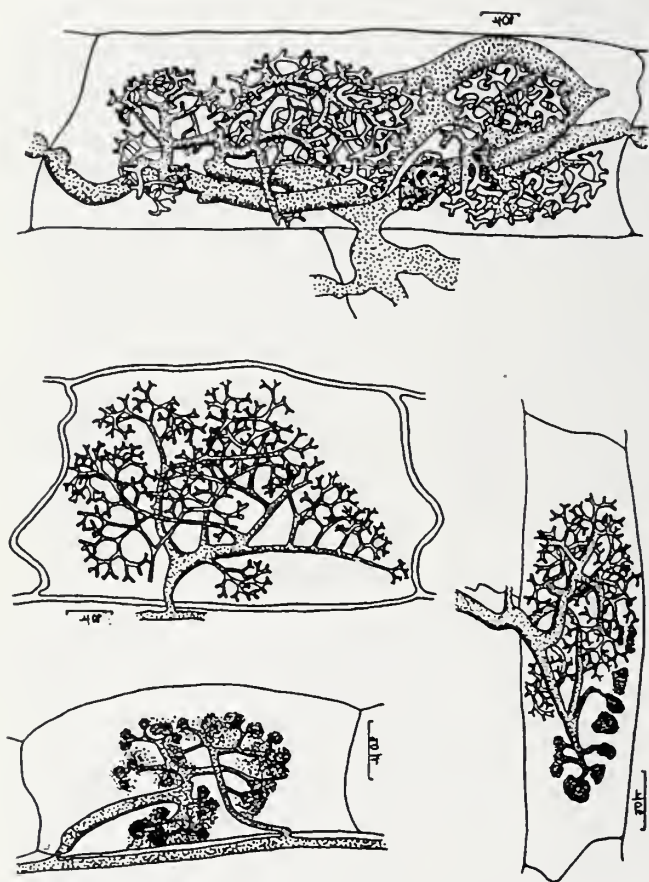
time studying *Monotropa* plants and their associated fungi, which helped him elucidate the function of mycorrhizae.

The mutually beneficial root fungi that Frank and the other nineteenth-century biologists discovered were all ectomycorrhizal. Although these were the latest to evolve, it is not surprising that they would be the first to be discovered since the short stubby roots and thick hyphal covering they produce are visible to the naked eye. Also, their reproductive structures are quite large and obvious, many even more so than truffles, because they form as aboveground mushrooms.

It is impressive that within just a decade of Frank's pioneering work with ectomycorrhizae, scientists also discovered the arbuscular mycorrhizae, which can only be seen with a microscope. However, the latter were initially thought to be parasitic. In 1905, a French researcher named I. Gallaud published a set of outstanding drawings of his microscopic observations of this fungal-root interaction, which he referred to as "endomycorrhizae." These drawings were our first view of this most ancient type of mycorrhizae, and Gallaud's drawings are still used in some modern textbooks to depict them.

Some paleobiologists have made the intriguing speculation that plant roots may have actually evolved from the earliest fungal symbionts of rootless green algae. The evolutionary progression from an intimate symbiosis between two species to their complete integration into a single organism has been documented in other cases. The biologist Lynn Margulis was one of the early proponents of this form of evolution, and argued for many years that the green chloroplast organelles (where photosynthesis takes place) found in the cells of green plants originated from an ancient symbiosis between a photosynthesizing cyanobacteria and a larger, single-celled (eukaryotic) organism. Many were skeptical of Margulis' "endosymbiosis" theory, even when it was discovered

that chloroplasts contain their own genetic material that is separate from the genes contained in the nuclei of the plant cells they inhabit. Recent comparative analyses of the nucleotide sequences of chloroplast and cyanobacteria genetic material have revealed a remarkable similarity. This more or less settled the matter, and most now accept the endosymbiotic pathway for the evolution of photosynthesizing plant cells. However, in the case of plant roots, no trace of genetic material to prove a fungal heritage can be found, and few plant biologists are convinced that roots evolved from fungi.



Microscopic images of arbuscular mycorrhizae as drawn by the pioneer researcher I. Gallaud and first published in Revue Generale de Botanique 17 (1905).

It is only in the relatively recent evolutionary past that a handful of plant families have gained independence from the symbiosis with fungi. The exceptions to the rule can literally be counted on one hand, and include Chenopodiaceae, common species being spinach and the weed known as lambsquarters; Brassicaceae, such as cabbage, broccoli, and wild mustard; and Amaranthaceae, such as edible amaranth and pigweed. Even among these plant families, some particular species are mycorrhizal.

Next time you are walking among the mighty giants of a temperate or tropical forest, hiking through a grassy meadow, mowing your lawn, or puttering in the flower or vegetable garden, take a look around. Most of the plants you see, if they don't fall into one of those three exceptional

groups, are probably thriving through the good graces of their subsurface symbiosis with root fungi. Mycorrhizae are particularly essential for survival during those periods of water and nutrient stress that almost every plant must occasionally face—the “ecological crunch,” as mycorrhizal researcher, Michael Allen, calls it. Without the fragile, gossamer-like net of subterranean fungal hyphae at their base, the towering redwoods, oaks, pines, and eucalyptus of our forests would collapse during hard times. Beneath every great tree there is a fungus, you could say. And the same can be said of most other plants as well. Mycorrhizal fungi form the foundation of most terrestrial ecosystems on the planet, from our orchards, vineyards, and other farmlands, to the vast savannas of Africa, the heathlands of Scotland, the tropical rainforests of South America, and the deserts of the American Southwest.

So just what is it about mycorrhizae that make plants willing to devote as much as 20 to 30 percent of their carbon and energy to support them? What are they doing that plant roots alone cannot? The secret lies in the unique structure of the fungi themselves: the hyphal threads are an order of magnitude finer than the finest of root hairs and thereby provide access to nooks

and crannies in the soil that could not otherwise be penetrated. This is especially helpful in acquiring certain nutrients, such as phosphorus, potassium, copper, and zinc, that do not move freely with the flow of water being taken up by roots. The finest of root hairs will have a diameter of 20 to 30 micrometers (about the diameter of a hair pulled from your arm), while the diameter of a strand of mycorrhizal hyphae is only one to two micrometers.

The capacity for a plant to exploit a given patch of soil expands tremendously with the prolific growth of their subterranean fungal partners. If one were to take a cubic centimeter of soil (about a teaspoonful) from the root zone of a mycorrhizal plant and spread all of the bits and pieces of root and root hairs end-to-end, the

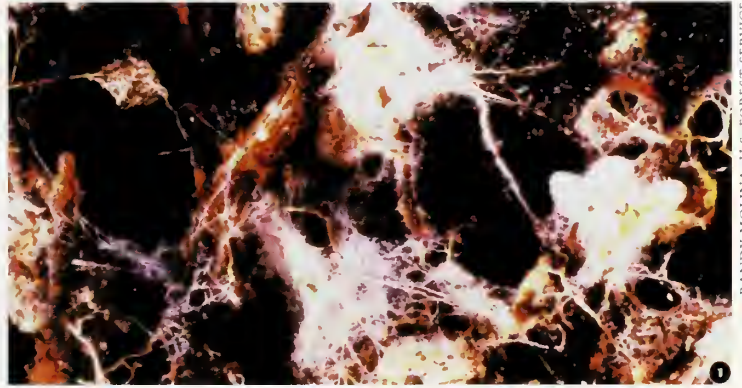
total length might measure a few inches. In that same volume, the length of mycorrhizal hyphae, if completely unraveled, might range from 60 to 120 *feet* (20 to 40 meters)! It is primarily the superiority of mycorrhizae at mining the soil for water and nutrients that makes it worth the cost to the plant. Some have speculated that in some mycorrhizal associations the roots are doing little more for the plant than serving as a vehicle to transport the attached fungi to deeper soil layers.

In some ecosystems the mycorrhizal fungi do not just function as passive absorbers of nutrients but also as active decomposers. Like many other fungi involved in decomposition, they are capable of releasing powerful enzymes that can externally "digest" wood and other organic matter. Before the liberated nutrients have a chance to float away in the soil environment, they are immediately snapped up by the fungus and directly transmitted to the plant hosts. This short-circuiting of the nutrient cycle is particularly valuable to plants in tropical ecosystems, where heavy rains often wash free-floating soil nutrients below the root zone before they can be absorbed.

Evidence has been accumulating over the past several decades that, in addition to enhancing the function of the individual roots they inhabit, mycorrhizae also often serve as a living subterranean connection between plants of different species through which water, nutrients, and possibly other substances can be transferred. Mycorrhizal fungi are not nearly so host-specific as the nitrogen-fixing bacteria discussed earlier, and because of this they often spread from plant to plant and species to species. The fungi do this for purely selfish reasons, of course, not with the objective of creating a pipeline between plants. For the fungi it is to their advantage to attach to any plant that will have them, as a means of maximizing their intake of the products of photosynthesis.

The movement of nutrients from plant to plant via mycorrhizae was first clearly demonstrated in a field experiment conducted in the

mid 1960s. Researchers applied radioactively labeled calcium and phosphorus to the cut stump of a maple tree and then tracked the movement of the calcium and phosphorus into attached mycorrhizae and eventually into adjacent plants. Since then, the movement of cal-



The threadlike hyphae of mycorrhizal fungi sometimes connect roots to each other and can serve as a belowground conduit of water and nutrients from one plant species to another.

RANDY MOLINA, U.S. FOREST SERVICE

cium, phosphorus, carbon, and nitrogen from plant to plant has been demonstrated among many plant species and in many ecosystems.

In several studies scientists have documented the movement of atmospheric nitrogen fixed by legume plants to adjacent nonlegume plants via a mycorrhizal conduit. Nitrogen transfer from clover and soybean to maize has been demonstrated, and in one study, as much as 15 percent of the nitrogen fixed by a species of alder tree was transferred to nearby pine trees through a fungal connection. This is an amazing phenomenon of unwitting cooperation. It requires the symbiosis between nitrogen-fixing bacteria and their legume host plant, as well as a willing mycorrhizal fungus attached simultaneously to the legume and nonlegume plant to act as the pipeline for transport of the nitrogen.

The importance of the underground plant-to-plant mycorrhizal conduits remains a matter of debate, but many are convinced that in some ecosystems the sharing of resources through such networks is so great that the plant communities function as a unified "guild" and the distinction between individual plants becomes blurred.



Like many soil fungi, the aboveground fruiting structures (mushrooms) of ectomycorrhizal fungi often appear in a "fairy-ring" pattern. This pattern is formed as the fungus grows slowly outward from a central point, with fruiting bodies produced only at the active growing points along the perimeter. The pen at center gives scale.

How large are these underground networks? No one knows for sure. It is quite possible that plants and mycorrhizae of many species could be loosely linked together over tracts of land measuring many acres. The maximum distance nutrients or other substances can be transported via mycorrhizae, and to what extent this might lead to a sharing of resources among plants, is still poorly understood. What we do know is that the spread of an individual fungus organism can be substantial—for example, "fairy rings" of ectomycorrhizal mushrooms several meters in diameter are commonly observed surrounding pine, oak, or other host trees. A fairy ring is the aboveground manifestation of an individual subterranean fungus that may be several hundred years old. The fairy ring pattern is formed as the fungi grow slowly outward from a central point, and the reproductive structures (mushrooms) pop up from the perimeter where the most active, healthy parts of the fungus are.

Some nonmycorrhizal types of soil fungi are among the oldest and largest living creatures on Earth. For example, in 1992, genetic analysis of samples of the wood-eating fungus *Armillaria*

bulbosa, collected in a Michigan hardwood forest over an area equivalent to several football fields, showed that it was a single organism that had been alive and had remained genetically stable for more than 1,500 years. The estimated weight of this individual fungus was 220,000 pounds (100,000 kilograms), equivalent to the weight of a blue whale! So far, no beneficial mycorrhizal fungus has yet been found that is as large as this hefty monster, but undoubtedly a series of mycorrhizae, networking from root to root and plant to plant, could encompass a very large area.

Even in the absence of physical plant-to-plant hyphal connections, the ubiquitous mycorrhizal symbiosis between individual plants and fungi plays a key role in linking the activities of subterra-

nean creatures with life at the surface. In the broadest terms, it provides aboveground life with greater access to water and nutrients stored in the soil, while supplying life in the underground with greater access to the carbon and solar energy collected by plants. The productivity of virtually all terrestrial ecosystems relies on this exchange of energy, water, and nutrients between the surface and subsurface.

Although mycorrhizae have been known for over a hundred years, it is only very recently that their essential role in the functioning of most terrestrial ecosystems, and in the evolution of land plants, has come to be fully appreciated. For much of the twentieth century, most scientists adopted a very skeptical view of cooperation between species. The reports of mycorrhizae were seen as isolated incidents. They were considered intriguing but of ecological significance only in very special environmental circumstances. When I was in graduate school in the early 1980s, a small number of ecologists had begun to recognize that we had underestimated the prevalence and importance of mycor-

rhizae, but it is only in the past ten years or so that the textbooks have caught up.

For a long time scientists had trouble reconciling the coevolution of mutually beneficial symbioses with twentieth-century discoveries of the "selfish" mode of gene action. Also, mathematical models, which were new to ecology in the 1970s and 80s, "proved" that mutually beneficial symbioses between two species were inherently unstable. The outcome of these computer simulations led to the conclusion that successful cooperation between species would seldom persist because "cheating" was usually too advantageous, at least at the individual level and in the short term, which is the level at which evolutionary forces operate.

Today, less than twenty years later, there has been a complete turnaround in our thinking. This has been due in part to the sheer weight of empirical evidence that has demonstrated the essential function and ubiquity of mycorrhizal associations with plants. This research was carried out primarily by a handful of dedicated soil ecologists during the 1970s and 80s who were not dissuaded by the majority opinion that their work with root fungi was esoteric and insignificant. Over and over again they showed that as long as samples were handled correctly to preserve their integrity, wherever there were active plant roots, there were active mycorrhizal fungi collaborating with them.

The "icing on the cake"—the genetic evidence—has only been attainable in recent years. With today's technology, we can grind up a tiny sample of root or soil, isolate the fragments of DNA released, and if mycorrhizal DNA is present, it will pair up with "fingerprint" nucleotide sequences of known mycorrhizal DNA that are added to the mix. This sounds complex, and it is, but with today's automated genetic analysis methods, it is much faster than tedious microscopic examination. Most important, it allows positive identification even in samples where most of the fungi have been lost or killed by mishandling, and would never be identified otherwise.

Today it is widely accepted that nearly 90 percent of plant species enter into mycorrhizal associations with fungi. This recognition of the

prevalence and profound importance of this subterranean symbiosis has had an impact beyond soil ecology. Our understanding of the forces of evolution and our mathematical models used to depict species interactions have matured as a result of this work. Evolutionary biologists now recognize that "even with selfish genes at the helm, nice guys can finish first," as Richard Dawkins, author of *The Selfish Gene*, so aptly put it.

The mathematical population models used by ecologists have been improved to better reflect this reality. The early models were mostly "equilibrium" models, which assumed that nature reached a more or less steady-state situation with regard to population levels of species. Today we better appreciate the fact that in the real world there are simply too many natural disturbances—invasions by new species, dramatic weather events, forest fires, plagues—for equilibrium to ever be reached. And it turns out that when disturbance is commonplace, cooperation, both in our mathematical models and in the natural world, can persist and often flourish. We have also learned that dominance of one partner over another can be prevented when there are "third party" species that are predators of species involved in the symbiosis. For example, in nature, small soil arthropods such as springtails often feed on mycorrhizal fungi, perhaps keeping them in check so that they do not become pathogenic to their plant hosts. The newer models have also been reconfigured to take into account the fact that a little bit of "cheating" is tolerable when the partners are as distinct in size and morphology as are plants and fungi. All of these changes have led to a better match between the real world, where symbiosis clearly thrives, and the simulated world predicted by mathematical models.

David W. Wolfe is associate professor of plant ecology in the Department of Horticulture at Cornell University and a member of Cornell's biogeochemistry program. Much of his research is focused on soil conservation and the impact of climate change on plants and soil. This article is from his book *Tales From the Underground: A Natural History of Subterranean Life*, 2001, and is reprinted by permission of Perseus Publishing. All rights reserved.



E. H. Wilson in western China, 1908, with his dogs, his traveling companion Walter Zappey, and villagers. Zappey's mission was to collect bird skins and animal pelts for Harvard's Museum of Comparative Zoology.

Wilson's Lost Tree

Mark Flanagan

The itineraries followed by Ernest Henry Wilson during his plant-collecting trips to China between 1899 and 1911 are notoriously difficult to reconstruct. He ranged widely over huge areas, often where maps were rudimentary or nonexistent. Many of the placenames of locations he visited—for the most part settlements comprising a few houses—were obtained from local people and written down phonetically. Added to this, the later changes in Chinese-to-English transliteration make it almost impossible to identify these places. To make things even worse, although Wilson wrote prolifically, he never produced a chronological narrative of his journeys. His primary account of the time he spent in China—*A Naturalist in Western China* (1913; later revised and republished as *China, Mother of Gardens*, 1929)—is more a series of vignettes than a travelogue. Furthermore, his personal journals are not in diary format, with one day following another, and his field notes are of little value to people trying to retrace his steps.

I have traveled in China on three occasions, but it was not until my third trip, last autumn, that I visited the western part of Sichuan province, where Wilson traveled extensively on his second and third trips. This area lies in the Da Xue Shan (Big Snow Mountains), dominated by the giant peak of Gongga Shan, at nearly 25,000 feet (7,556 m) by far the highest mountain in Sichuan.

In *China, Mother of Gardens*, Wilson's travels in this area are described in the chapters entitled "Across the Chino-Thibetan Borderland" and "Tachienlu: The Gateway to Thibet," which deal with the journey that he undertook for the Arnold Arboretum in the summer of 1908. In general, his route ran due west from Chengdu to Tachienlu, the latter town well known to other botanical explorers and today called Kangding. His exact course is impossible to puzzle out,

however, as few modern names resemble those he cites. In addition, his narrative ends when he reaches Tachienlu on July 23, 1908, though it is clear from his photographs that he continued traveling through the rest of the summer and retraced some of his steps in the autumn to collect seeds.

My own trip to this region, under the auspices of the Royal Botanic Gardens, Kew, was part of a collaboration between Kew and the Institute of Biology in Chengdu that since 1987 has sponsored seven expeditions to Sichuan for collecting plants of horticultural value. Our team was headed by Tony Kirkham, head of the Arboretum at Kew, and also included Steve Ruddy, an information technology specialist from Kew, and Bill McNamara, director of the Quarryhill Botanical Garden in Sonoma, California. Bill is among the most experienced of modern-day travelers in China, having visited the country more than fifteen times. Though we intended to visit Kangding, we had little expectation of finding any signs of E. H. Wilson's passing.

Starting at Chengdu, we took the recently constructed expressway to Ya'an and continued on into the valley of the Dadu River (in Wilson's day, the Tung River) via a tunnel that cuts through the lowering bulk of Erlang Shan. Our first overnight stay was in Luding, well known to plant hunters past and present and famous for its old iron bridge, which spans the Dadu River. It was over this bridge that in 1935 troops of Mao Zhedong's Red Army launched a heroic and successful assault on Kuomintang positions on the opposite hillside.

The next day we drove north to Kangding, our base for a week or so while we collected in the mountains to the northwest and west. From there we returned to the Dadu River valley and headed towards the ancient town of Moxi. On the way we stopped to admire the huge, ancient ginkgo tree at Lengji. We were told that it is at



least two thousand years old. Like the old oak trees I know from Windsor Great Park, this veteran continues to defy the years despite being full of dead branches. The tree, with small buildings nestling in the folds of its trunk, is very much a part of the local community. A 76-year-old Chinese lady called Mrs. Wang related its history for us with evident pride.

We arrived in Moxi in the late afternoon of September 16. Moxi occupies a beautiful site in a deep valley, with large, snow-capped mountains to the west and rich, mixed forests covering the nearby hillsides. The town sits on an island between two arms of the Moxi River, a position that in the past was important for defensibility.

Over dinner in the recently built Red Army Hotel, we asked whether there were any old trees in the vicinity. Yin Kaipu, our expedition guide, replied that yes, there was a famous old *sha shu* at the top of the town. *Sha shu*, the Chinese fir (*Cunninghamia lanceolata*, Cupressaceae), is a very common tree in the temperate regions of China. Its timber is so highly valued that it is grown in plantations and large trees are rare. We therefore expressed an interest in visiting the tree. "Fine," said Professor Yin, "but it died several years ago." We were disappointed but still wanted to see the tree.

So after dinner we walked through the rapidly gathering twilight up the main street of old Moxi. As the tree's silhouette came into view above the surrounding buildings, I felt a strange sense of recognition. Then, when we had cleared the last of the buildings, I blurted out, "I know this tree." As my companions knew I had never been anywhere near Moxi before, they were rightly incredulous. "I know this tree," I repeated. "It was photographed by Wilson." The characteristic shape and distinctive leaning posture of the tree made me certain that it was the same one I had seen in a photograph by Wilson in W. J. Bean's *Trees and Shrubs Hardy in the British*



The Cunninghamia lanceolata at Moxi on 29 September 2001, now surrounded by recent buildings. This is as close as it is possible to get to Wilson's original position.

Isles (8th edition revised, 1970). But how was I to prove it?

Steve Ruddy quickly came to my assistance. Using a satellite telephone linked to a laptop computer, he e-mailed the Gardens Development Unit at Kew and asked the staff to look for the photograph in Bean and, if successful, to e-mail it to us.

The following morning there was nothing from Kew. We spent the day trekking up the nearby Yanzi valley, partly on foot and partly on



A second view of the tree and its attendant temple.

horseback, to just below 10,000 feet (3,000 m). Along the way we made some wonderful collections. The forests, almost pristine, have a huge variety of broadleaved trees and shrubs. Higher up we encountered massive specimens of Chinese hemlock trees and, eventually, *Picea asperata*, the dragon spruce.

Back at the hotel that evening, there was still nothing from Kew. But early the next morning, Steve woke me to say that an e-mail and the image had arrived from Kew. When the full image was finally downloaded onto the screen, the configuration of the hill in the background and the leftward lean of the tree left little doubt

that it was the tree we had seen. What's more, the caption at the foot of the image read: "*Cunninghamia lanceolata*. A photograph taken by E. H. Wilson southeast of Tatsien-lu in 1908." Moxi does indeed lie to the southeast of Tatsien-lu (Taichienlu, Kangding).

We hurried out to compare the image with what remains of the tree, debating about where Wilson was actually standing when he took the photograph. The town has expanded considerably since Wilson's time, and the view he captured is now partly obscured by buildings.

Wilson's photograph shows a small temple at the foot of the tree and a field of maize all around it. Amazingly, the temple remains, though much changed, and the surrounding fields are still full of maize. Through our interpreter, Zhong Shengxian, we spoke with the caretaker of the temple, Feng Wan Lin. He told us that the tree was more than a thousand years old and that the original settlement of Moxi grew up around it. He said that it had caught fire in 1992—scorch marks can be clearly seen on the trunk—but there is no plan to cut it down since it is still revered despite its moribund state.

In a buoyant mood we continued our journey. For the next three weeks we skirted the great mountain of Gongga Shan, visiting several of the river valleys that discharge meltwater from the snows and glaciers of the peak.

Back in England, I began serious research into Wilson's movements during his 1908 trip to China. Though I suggested earlier that nothing in *China, Mother of Gardens* links Wilson to Moxi, this is not strictly true. In a later chapter, "The Principal Timber Trees," Wilson speaks of *Cunninghamia* and of its use by the Chinese for coffins. He discovered that the preferred timber for making coffins was called *hsiang-mu* (fragrant wood), which was *Cunninghamia* that had been buried either deliberately or by landslides. Wilson had seen coolies excavating very large trunks of *hsiang-mu* near the hamlet of Wan-Ting-Dung, between Fulin and Mohsi-mien

(Moxi) while on his way to Tachienlu in 1904. Intriguingly he added, "In all my travels in China I have seen only one living specimen of *Cunninghamia* approaching the size of these long-buried giants." Surely this must have been the tree at Moxi.

I then looked at Wilson's original expedition photographs, which were bound in ten volumes by the Arnold Arboretum and which include the photo of the Moxi tree that I had remembered from Bean. Wilson was an excellent photographer, and these images provide an invaluable record of his third and fourth journeys to China, as well as of his subsequent trips to Korea, Japan, and Taiwan. Unfortunately, though they are dated and the locations are given, they are not arranged in chronological order, so I had to look through all the pictures to establish the sequence of events and correlate them with the text of *China, Mother of Gardens*.

The itinerary that I reconstructed is as follows, with modern placenames included in parentheses. Wilson's party left Chengdu on June 15, 1908, traveling northwest to Kuan Hsien (Guan Xian). Within a few days they were in the mountains, crossing a pass in the Pan Lan Shan (Qionglai Shan) on June 21. From there they continued west, arriving at Monkong Ting (Xiaojin) on June 27 and Romi Chango (Danba) on June 30. Wilson spent the next ten days traveling south through the Da Xue Shan, arriving in Tachienlu (Kangding) on July 11. Within two days he was on the road again, crossing into the Tung (Dadu) River valley and arriving at Moxi on July 16 or 17. The photograph of the *Cunninghamia* is dated July 17, 1908.

To confirm matters beyond doubt, I enlisted the help of Peter Del Tredici, director of the Living Collections at the Arnold Arboretum, who kindly looked into the Wilson archive for me. Wilson's journal contains very little information for the period in question, merely stating that the time between July 13 and 20 was spent on a trip to Moshi-mein and Ya-chia-k'an. Peter also found a letter dated December 19, 1908, and written in Kiating (Leshan) to Charles S.



Caretaker Feng Wan Lin outside the temple at the base of the tree in Moxi.

WILLIAM A. MCNAMARA, QUARRYHILL BOTANICAL GARDEN

Sargent, the Arboretum's director. The letter adds important information about the tree in Wilson's photograph:

In all my wanderings I have only met with one really large (*cunninghamia*) tree. This occurs two and a half days south-east of Tachienlu at an altitude of 5,000 ft. When photographing this tree I estimated it at 120 feet by 20 feet. Seed no. 794a is from this particular tree." [Italics are mine.]

I now felt that the evidence showed overwhelmingly that the dead tree we saw at Moxi is the same tree that Wilson visited, photographed, and collected seeds from.

One small detail remains. Remarkably, a living tree from Wilson's collection 794a is represented in the collection at the Younger Botanic Garden at Benmore, an outstation of the Royal Botanic Garden Edinburgh, near Dunoon, Scotland; there may also be representatives in other gardens. Peter Baxter, the curator at Benmore, reports that the tree is about ten feet (three m) tall and in good health. Its history is somewhat obscure, but it is known to be a propagule from an older tree, presumably now dead. It would be a fine gesture to propagate a sapling from this tree to take to Moxi in honor of the greatest plant collector of them all.

Mark Flanagan is Crown Estate Keeper of the Gardens at Windsor Great Park, England.

ACROSS THE CHINO-THIBETAN BORDERLAND TO TACHIENLU*

E. H. Wilson

During the summer of 1908, when in Chengtu, I determined upon a journey to Tachienlu. Previously, in 1903 and again in 1904, I had visited this town by three different routes. This time I decided upon traversing the road leading from Kuan Hsien via Monkong Ting and Romi Chango. The only published account of this route that I have knowledge of is in a report by Sir Alexander Hosie [1905], erstwhile H.B.M.'s Consul-General at Chengtu, who returned from Tachienlu over this road in October 1904. What is written in this report about the forests of that region created an appetite within me which nothing short of actual experience could satisfy. Again, this route promised further acquaintance with the tribesfolk inhabiting the hinterland. Sir Alexander's description of the road portrayed a difficult journey, but I felt sure that by taking time and but lightly burdening my men I could get through all right. This confidence was fully justified, as events proved, and what I saw of the forests and mountain scenery, together with the quantity and variety of plants discovered and collected, abundantly repaid for the hardships experienced.



Larix potaninii. Tree 60 ft x 8 ft. Forests of the Ta-p'ao-shan. Altitude 12,800 ft.

* All photographs are from the Archives of the Arnold Arboretum and were taken by E. H. Wilson in 1908 during his first plant-hunting expedition for the Arnold Arboretum. The text, which is excerpted from his *China, Mother of Gardens* (1929), sketches the journey that took him to Moxi and its giant *Cunninghamia lanceolata*.

A 1976 issue of *Arnoldia*, volume 36, number 5, was devoted to "E. H. Wilson, Photographer" by Peter J. Chvany; copies are still available.



Populus szechuanica. Tree 60 ft x 10 ft. Altitude 8,400 ft.



Actinidia chinensis (now *A. deliciosa*). Flowers 1 1/2 inches across. Altitude 4,600 ft.

Early next morning we continued our journey, spending the whole day toiling up the ravine through savage, yet wondrous, scenery, with a profusion of vegetation on all sides. Coniferous trees preponderate . . . Yew is less abundant, but Larch (*Larix Potaninii*) much more so, though large trees are very scarce. To my astonishment the Larch cones were ripe, and I collected a quantity of seed. A Poplar (*Populus szechuanica*) with large leaves, silver gray on the under side, is very common, and we passed some very large specimens. A Rose with large bright red flowers made a fine display, so also did the pink flowered *Deutzia* mentioned above. . . . Many kinds of Maple, Linden, and Mountain Ash are plentiful, and *Tetracentron sinense*, an interesting tree exceeding in size all other deciduous trees of this particular region, occurs sparingly. Hydrangeas, Spiraeas, Honeysuckles, Mock-oranges, Brambles, Roses, Actinidia, Clematoclethra, Viburnum, and other ornamental shrubs struggle for possession of every available spot. The variety and wealth of bloom was truly astonishing, and I know of no region in western China richer in woody plants than that traversed during the day's march.



At Êrh-tao chiao [altitude 6,000 ft.] I photographed a magnificent Juniper (*Juniperus squamata Fargesii*), a tree 75 feet tall, 22 feet in girth, with graceful pendent branches.



At 12,000 feet, *Juniperus squamata* grows as elfin-wood.



Above 11,500 feet altitude . . . *Primula Veitchii* was a pleasing sight with its bright rosy pink flowers. All the moorland areas are covered so thickly with the Thibetan Lady-slipper Orchid (*Cypripedium tibeticum*) that it was impossible to step without treading on the huge dark red flowers reared on stems only a few inches tall.





Picea retroflexa (now *P. asperata* var. *retroflexa*), a Chinese spruce. Altitude 10,500 ft.

Photography in the forests is no mere pastime. It took over an hour on three occasions clearing away brushwood and branches to admit of a clear view of the trunk of the subject. I secured a dozen photographs, which entailed a hard day's work.



Chinese roads make a lasting impression on all who travel over them, and the vocabulary of the average traveler is not rich enough to thoroughly relieve the mind in this matter. . . . Just outside Hsin-kai-tsze the road crosses over by a log bridge to the right bank of the [Hsaochin Ho]. This bridge was being repaired, and only two very uneven logs were in position. A thin rope was stretched across to serve as a handrail on the left side. Crossing was really dangerous, the waters below being deep and turbulent. The official kindly provided local experts to carry our gear over, and the way these men accomplished the task filled me with admiration. I rewarded them with 1000 cash, to their astonished delight. My dog was lashed firmly to a flat board and carried across on a man's back. He struggled violently, and the man only just managed to get him over before he got half loose. I walked over behind the dog and was relieved when the 30 yards across the yawning gulf were safely passed. Everything came over all right, but my followers clung to the local men like grim death, the majority shaking in their nervous fright. Such dangerous entertainments are not desirable, and I heartily hoped that we had no more such bridges to cross.



The main road China to Lhasa (capital of Thibet) hereabouts blasted out of hard rocks.



Men laden with "Brick Tea" for Thibet. One man's load weighs 317 lbs. Avoird; the other's 298 lbs Avoird!! Men carry this Tea as far as Tachienlu accomplishing about 6 miles per day over vile roads. Altitude 5,000 ft.



With the weather conditions so favorable the view from the summit of the [Ta-p'ao shan] pass far surpassed my wildest dreams. It greatly exceeded anything of its kind that I have seen, and would require a far abler pen than mine to describe it adequately. Straight before us, but a little to the right of our viewpoint, was an enormous mass of dazzling eternal snow, supposed to be, and I can well believe it, over 22,000 feet high. . . . Looking back on the route we had traversed we saw that the narrow valley is flanked by steep ranges, the highest peaks clad with snow, but in the main, though bare and savage-looking, they scarcely attain to the snow-line. On all sides the scenery is wild, rugged, and severely alpine. A cold wind blew in strong gusts across the pass, and we were glad when our photographic work was finished, so that we could hurry down.

Plant Response to Pruning Cuts

Lee Reich

Pruning causes anguish in many gardeners. As a result many of them approach the job with too much timidity, wincing with pain at each cut; or else they go to the other extreme. No wonder, given all that's been written about the pruning needs of specific plants or groups of plants. In fact, though, all plants respond to pruning in qualitatively the same manner. Once we understand just how the stems of plants respond to being cut—whether they are mighty oaks or midget marigolds—we can better (and more confidently) prune.

The Effects of Pruning: General vs. Local

Pruning stems dwarfs plants. Leaves produce food for a plant, and the stems are one place where plants squirrel it away for later use. Cut away a stem, and you leave the plant with less food.

Many gardeners might argue with my assertion that pruning dwarfs plants. Who hasn't drastically cut back a tree or branch in late winter, only to watch new shoots grow with great vigor when compared to their more sedate, unpruned counterparts? And the more severely the tree or branch was cut back, the more energetic the response of the remaining buds.

But pruning has not stimulated growth; it has caused "local stimulation," that is, stimulation of the buds just below the point where pruning occurred. If you were to add the weight of the pruned stems to the weight of new growth that the tree would have made had it not been pruned, you would find the total to be significantly greater than the actual weight of new growth on the pruned tree.

In addition to dwarfing the plant, pruning will cause local effects, including changes in plant form as well as in the quantity of fruits and flowers. Often we may be willing to accept some amount of undesired dwarfing just because we want to prune for these local effects. By understanding how a plant responds to cuts, the gardener can achieve the desired result whether or not a general dwarfing of



KAREN MADSEN

the plant is one of the aims. Pruning a stem can strengthen it, induce flower buds, and/or cause branching, but the effect depends on both the degree and timing of your cut.

Effect of the Degree of Cutting

Plants do show some differences when their stems are pruned, but the differences are quantitative rather than qualitative, so general rules are useful. For example, picture a young shoot, less than a year old, be it the main stem of a tomato plant or an apple tree. Unpruned, the stem will continue to grow from its tip, and side branches may or may not grow out farther down along the stem.

The number and the vigor of side branches depends on the vigor of the plant. Those on a tomato plant, for example, may be numerous and strong enough to match or overtake the length of the main stem. On the apple tree, though, side branches might push out only a few inches of new growth.

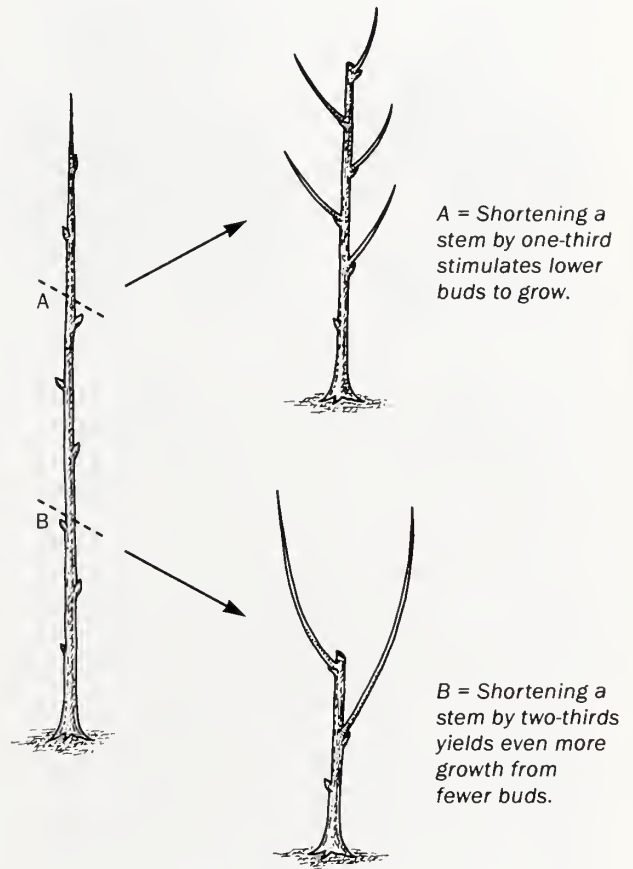
Pinching

For the least pruning possible on any stem, pinch off the growing point of a shoot with your thumbnail. This causes growth to falter briefly but has another effect as well. The tip of any stem releases a hormone called auxin that moves down the stem, inhibiting the growth of lower buds. Remove the stem tip and you stop the flow of auxin, awakening lateral buds that were dormant and inducing existing side shoots to grow more vigorously. Pinching is useful generally for slowing stem growth—to direct the energies of a tomato plant in late summer to ripening fruits, for example. It also encourages branching, as, for instance, on a potted avocado tree whose single, lanky stem looks ungainly.

Heading

A stem can also be shortened more drastically using pruning shears or a knife. This is called a heading cut, and the plant's response depends on

Response to Two Degrees of Heading Cuts



the degree of heading. If you cut a young stem back by a third, buds that might have stayed dormant on the remaining part of the stem will now be prompted to grow more enthusiastically than if the stem had been left alone. Shorten that same stem by two-thirds and the resulting new growth will be even more vigorous. (Remember: all this stimulation applies only to the cut stem; the plant as a whole is dwarfed by pruning.) Those buds nearest a heading cut are the ones that make the most vigorous, upright shoots; lower down, buds will push out growth that is less vigorous and comes out at wider angles to the cut branch.

Several general rules can predict the stem's reaction to heading. The more vigorous a young

Effect of Pinching

Pinching out the tip of a stem encourages branching.

stem before it is headed back, the more vigorous the response to such pruning. Also, the more vertical the orientation of a stem, the greater its vigor. And a heading cut into one-year-old wood elicits a more vigorous response than does a cut into older wood. Too many gardeners carelessly hack back their plants in an effort to get rid of unwanted growth, then bemoan the dense and vigorous regrowth from the heading cuts. In the right situation, however, a heading cut can be very useful. There are times when vigorous new growth is needed: to strengthen the trunk of a young tree; to create new bearing wood for fruits or flowers; for a decorative effect; to invigorate a frail stem. A heading cut is also the best pruning technique when branching is wanted, such as on a newly planted tree that has only a single upright stem.

Thinning

What happens if instead of cutting off only part of a stem, you remove it completely, or cut it back to a larger branch? This type of pruning is

called a thinning cut, and the plant's response is: nothing, near the cut. Or, at most, very little. (But remaining shoots on the plant will grow more than they would have otherwise.)

So use thinning cuts to remove unwanted growth, such as in the center of a tree or shrub where growth is too dense, and reserve heading cuts for situations where you want lush regrowth or branching.

The Time of Year

"Prune when the knife is sharp," goes the old saying. Not true. (But don't ever prune if the knife is *not* sharp.) A plant's response to pruning depends not only on how much you cut off a stem but also on when you do it. In temperate climates, as each growing season draws to a close, trees, shrubs, and vines lay away a certain amount of food in their above- and belowground parts. This food keeps plants alive through winter, when they cannot use sunlight to make food because of cold tempera-

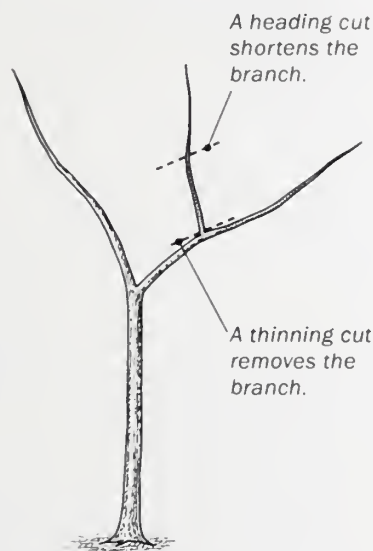
tures or, in the case of deciduous plants, because they lack leaves. The stored food also fuels the growth of the following season's new shoots and leaves, which eventually, as they mature, start manufacturing their own food and pumping the excess back into the plant for use in the coming winter.

Pruning a dormant stem removes buds that would have grown into shoots or flowers. Because food reserves within the plant are then reapportioned among fewer buds, the shoots from the remaining buds grow with increased vigor.

As the growing season progresses, a plant's response to pruning changes. Shoot growth of woody plants generally grinds to a halt well before leaves fall in autumn. In fact, growth commonly ceases by midsummer, so the later in the growing season that you prune, the less inclined a woody plant is to regrow, at least during the year of pruning.

Traditional theory holds that summer pruning is more dwarfing than dormant pruning, but recent research puts this theory on shaky

Heading vs. Thinning Cuts



footing. True, if you shorten a stem while it is dormant—in February, for example—buds that remain will begin to grow into shoots by March and April, whereas cutting back a shoot in mid-summer might result in no regrowth. Ah, but what about next spring? That's when, according to this recent research, the summer-pruned shoot will respond. Plants have an amazing capacity to act however they please no matter what we do to them.

What are the practical implications of this? First of all, if you want to stimulate bud growth, prune a stem when it is dormant. Summer, on the other hand, is the time to remove a stem to let light in among the branches (to color up ripening apples or peaches, for example), or to remove a vigorous stem that is in the wrong place. Upright watersprouts, for example, are less likely to regrow if snapped off before they become woody at their bases. Summer pruning can sometimes prompt the formation of flowerbuds rather than new shoots—just what you want for solidly clothing the limbs of a pear espalier with fruits or the branches of a wisteria vine with flowers.

The response to summer pruning also depends on the condition of the plant and on the weather. A weak plant may be killed by

summer pruning. A late-summer wet spell, especially if it follows weeks of dry weather, may awaken buds that without pruning would have remained dormant until the following spring. And these responses interact with the plant's response to various degrees of pruning.

You also must consider the effect on the plant's health when deciding when to prune. Although immediate regrowth rarely occurs after late-summer or autumn pruning, cells next to the cut come alive to close off the wound. Active cells are liable to be injured by cold weather—a good reason to avoid pruning in late summer or autumn except in climates with mild winters, or with plants that are very hardy to cold. Dormant pruning just before growth begins leaves a wound exposed for the minimum length of time before healing begins. Some plants—peach and its relatives, for example—are so susceptible to infections at wounds that they are best pruned while in blossom. On the other hand, the correct time to prune a diseased or damaged branch is anytime you notice it.

Also consider yourself (and your own welfare) when timing your pruning. Depending on the number of plants you have to prune, as well as other commitments, you may not be able to prune all your plants at each one's optimum moment. I prune my gooseberries in autumn (they never suffer winter damage), my apples just after the most bitter winter cold has reliably passed, and my plums (a peach relative) while they are blossoming.

Plants such as maples, birches, grapes, and kiwis bleed sap profusely if pruned just as their buds are swelling in spring. The way to avoid this is to prune either in winter, when the plants are fully dormant, or in late spring, after growth is underway. The sap loss actually does no harm to the plants, so you need not rush or delay pruning for your plant's health, but rather for your own peace of mind.

Lee Reich, PhD, is the author of *Weedless Gardening*, *Uncommon Fruits Worthy of Attention*, *A Northeast Gardener's Year*, and *Growing Fruit in Your Backyard*. This article was adapted from *The Pruning Book*, published by Taunton Press.

Of (Two) Gardens: Book Review

Phyllis Andersen

Men come to build stately, sooner than to garden finely; as if gardening were the greater perfection.—*Francis Bacon, Of Gardens (1625)*

The Greater Perfection: The Story of the Gardens at Les Quatre Vents. Francis H. Cabot. New York: W.W. Norton & Co., 2001. Hardcover, 327 pages, \$75.00.

The Garden at Highgrove. H.R.H. The Prince of Wales and Candida Lycett Green. New York: St. Martin's Press, 2000. Hardcover, 176 pages, \$35.00.

In his introduction to *A Greater Perfection*, the landscape architect Laurie Olin notes that being well connected to situation and setting is one of the most compelling ideas in garden design. Both Les Quatre Vents, Francis Cabot's magnificent garden on the Saint Lawrence River in Quebec, and Highgrove, the country estate of the Prince of Wales in the British Cotswolds, illustrate the essence of being "of a place."

Both properties were developed as a personal journey through gardenmaking. Neither Cabot nor the Prince of Wales worked from a professional master plan, although both called on expert advice from time to time. Both of these books reveal much about the gardens' creators as well as about their gardens. Francis Cabot appears to be a forthright and exacting individual. The challenge of his remote site suits him well. The Prince exhibits a playful modesty, a concern for both nature and art, and a surprisingly hands-on approach to enhancing his property.

Les Quatre Vents is well known in the garden world, since Mr. Cabot is the founder and chairman of The Garden Conservancy, an organization devoted to preserving exceptional private gardens in North America. He has lectured

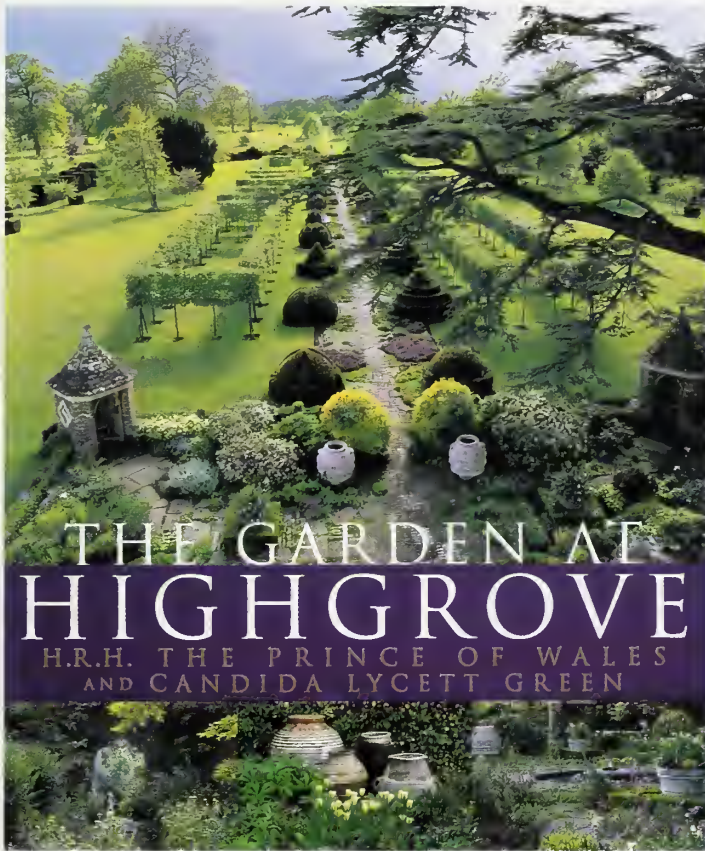
widely on his gardenmaking efforts at both Les Quatre Vents and Stonecrop, his home in Cold Spring, New York. We profit greatly from his decision to write this book after years of demurring ("too many books about gardens"). We learn here of his early ties to this piece of land—the childhood summers exploring the spruce and balsam fir forests—and of his own decision to expand his parents' simple garden when he inherited their property in the 1960s.

Les Quatre Vents sits within a thin slice of Zone 4, warmed by the river but surrounded by the daunting Zone 3 climate of the Laurentian Mountains. Cabot is an avid plantsman who clearly enjoys the challenge presented by the area's restrictive growing conditions:

If the snows arrive before the ground freezes and last throughout the winter, the horticulturist can proudly display plants that thrive only in the Himalayas or in Scotland. In the worst of years, when the snows don't come until it is too late, or even when an atypical winter thaw destroys the snow cover, it is another story, and a humbler horticultural outlook prevails.*

In telling us how he framed the structure of his garden, Cabot refers frequently to the dramatic topographic conditions of the site and to the native forest that surrounds it. He created a series of garden spaces using native species as his framework, counting on their hardiness to free him to give special care to the more vulnerable plants that create the lush displays within each garden room. Although spruce budworm undermined this strategy for a while, he continues to build allées and hedges of thuja, paper birch, amur maple. Some garden rooms have historic associations: a white garden was

* Francis H. Cabot, "'Les Quatres Vents,' a Far-Northern Garden," *Arnoldia* (1985) 45(4): 22.



by photographs that show a perfect garden, but it gives a sense of the growth and change that are an integral part of any garden.

Les Quatre Vents is the summer home of Cabot's family, but it is used for cultural events and is open to the public on appointment. In the book's afterword Cabot gives some valuable advice to garden visitors, based on his own experience as owner and traveler: avoid traveling in large groups, but if you must, break off and enjoy the garden as a solitary experience.

Unlike Francis Cabot, the Prince of Wales does not have multigenerational ties to his land. He purchased Highgrove in 1980 when it was a rather simple, late-eighteenth-century manor house set in a featureless landscape—just what the Prince was looking for, as he “didn’t want other people’s dreams and ideas.”

His goal was to anchor the house with a series of linked garden rooms.

inspired by Sissinghurst, and a watercourse emulates Geoffrey Jellicoe’s work at Shute. Some features evoke exotic locales—a swinging rope bridge modeled on those in Nepal; a series of Japanese structures built by a master carpenter from Japan; a Chinese moon bridge constructed over a woodland stream against a background of amur maple, golden aspen, and dark green thuja.

In recreating the life of this garden Cabot gives credit to the gardeners, craftspeople, consulting architects, and artists who offered advice, designs, or hands-on labor, and he is careful to reveal his own mistakes (and those of others). He notes his debt to Rosemary Verey’s *Englishwoman’s Garden* and tells a delightful story of following Russell Page as he walked around the garden giving an intensive, two-day critique. “Get rid of the fuzz,” admonished Page, referring to plants that interfered with vistas, or paths that meandered awkwardly and detracted from important features. Cabot’s text of struggle, gain, and loss in the garden is belied

The boundaries between the garden and the working farmland that forms part of the property are blurred. This results in part from the gentle topography of the site, but certain garden features also help integrate the formal garden scheme into its country setting: the linden-lined entry drive underplanted with wildflowers; the fenced pasture, visible from the house, for Aberdeen Angus cattle and black Hebridean sheep; the wildflower meadow, an area of much experimentation that is closely monitored by the Prince.

The Prince of Wales has a very public interest in organic gardening and in natural history studies. His complex composting program produces both high-quality leafmold for potting mixes and a less nutrient-rich product for mulches. The local constable assigned to the property for security reasons collects data on dragon and damselflies while making his daily rounds. The Prince maintains an orchard of rare apple varieties from the National Fruit Collection. He had the expert advice of the Marchioness of

THE GREATER PERFECTION

The Story of the Gardens at Les Quatre Vents

FRANCIS H. CABOT

Salisbury, a noted organic gardening specialist, and Miriam Rothschild, the British naturalist, early in the planning process. At the end of this book, the head gardener, David Howard, gives a short overview of organic gardening at Highgrove.

Nevertheless, the garden itself is an inspired contrivance: the golden yews lining the central thymic walk—each trained into an eccentric shape by the staff gardeners; a ten-foot-high glass pyramid filled with ferns in the woodland; the “park pale” deer fence of cleft oak, adapted from a Roman design, that encloses the chicken run. Even the walled kitchen garden, cultivated according to strict organic principles, rivals the potagers at Villandry in formality of design.

The garden reflects the Prince’s strong support of traditional architectural forms and of the British craft tradition. In the designers Julian and Isabel Bannerman he has found sympathetic minds that can adapt traditional forms into gar-

den elements of great originality. The column bird—a gigantic stork-cum-heron poised on a nest atop a column—was rescued from Victoria station in London; the stumpery is an artfully arranged tangle of upended stumps that support a lush display of hostas, hellebores, ferns, and euphorbia. Small touches by other artists and craftspeople—a Chippendale bench with bright blue struts, small wall plaques designed by contemporary artists using classical themes—make this garden intimate and intriguing. The Prince takes his role as patron very seriously, and it is to his great credit that the artists, gardeners, and assorted other experts who helped plan and make the garden are not only named and included in the photographs, but also identified by their previous experience and training.

Like Francis Cabot, the Prince of Wales opens his property to public tours and to a growing number of small conferences related to programs he supports. A conference center of golden Cotswold stone, called the Orchard Room, is a recent addition to the property.

The gardens described in both these books draw on traditional garden forms and historical references. While they cannot be called modern, they are clearly gardens of their own time. Both translate local vernacular forms and materials into original garden features. Both owners continue to experiment with plantings and structures—the Prince of Wales, for example, continually edits his plantings in an effort to find disease-resistant varieties with significant ornamental value, and Francis Cabot rethinks color schemes and plant combinations as new cultivars become available. One hopes that this personal quest for perfection is captured if these gardens take on a greater public role.

Phyllis Andersen is director of the Institute for Cultural Landscape Studies of the Arnold Arboretum.

The Arnold Arboretum

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Pursuing a Standard of Excellence

Robert E. Cook, Director

A decade ago, when the Arboretum began a complete renovation of the Hunnewell building, our main administrative facility, I had no idea that it was only the beginning of a major program of infrastructure renewal. At the time, we borrowed three million dollars from Harvard, added one million of our own, and hoped we could handle the mortgage payments. The result was an exceptionally beautiful restoration of the late-nineteenth-century character of

this wonderful structure, originally built by Charles Sprague Sargent to house his arboretum.

The past decade has been good to us. The growth of our endowment has been excellent, thanks to the stewardship of the Harvard Management Company, and we raised ten million dollars in a university-wide campaign. Over the past five years, this has allowed us to extend to our landscape the high standard set by the Hunnewell renovation project.

With help from the Boston Parks Department and the Arboretum Park Conservancy, we acquired a fifteen-acre parcel of sadly neglected wetland adjacent to the grounds and began to restore it to its natural character. To facilitate access by the public, we created a new entrance with ornamental gates, stone piers, and a formal pedestrian pathway to connect the wetland to our older landscape. On the west side of

● *continued on page 2*

2001 Visiting Committee Meets at Arboretum

Every eighteen months, the Committee to Visit the Arnold Arboretum convenes in Jamaica Plain, most recently in mid October. The twelve members of the committee toured the South Street pedestrian pathway and the site of the shrub and vine garden; visited the plant morphology and anatomy lab with horticultural taxonomist Jianhua Li; discussed past accomplishments and future goals of the Arboretum with members of the staff; and met with Sally Zeckhauser, Harvard's vice president for administration.

They also enjoyed a slide talk, "Plant Hunting on the Rooftop of the World," by curatorial associate Susan Kelley, who presented scenes and specimens from her collecting

● *continued on page 3*



The 2001 Visiting Committee with staff members: *At front*, Joan Hutchins, Bob Cook, Nod Meyer, Judy Zuk; *middle row*, Christopher Campbell, Michael Donoghue, Matthew Kiefer, Peter Del Tredici, Richard Schulhof; *at back*, Richard Primack, Julie Coop, Richard Pagett, Paul Zofnass, A. David Davis, Henrik Blohm, Roger Swain, Marten Liander.

Chris Santos

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the Arboretum, construction has begun on a similar set of ornamental gates and stone piers that will greatly improve the transition between the historic arboretum designed by Frederick Law Olmsted and the Peters Hill section.

Our largest project, just now approaching completion, has created an entirely new infrastructure out of wood, steel, and stone on a three-acre hillside below the Dana Greenhouse. In the spring we will begin planting an extensive collection of sun-loving shrubs and vines on a series of terraces retained by exquisite field-stone walls. This new garden was made possible by a generous

future bequest from Frances Leventritt in memory of her husband, M. Victor Leventritt.

All these new projects set a very high standard for the rest of our grounds. Inevitably, certain aspects of our older infrastructure—walls in need of repointing and restoration, eroded paths and stream-banks, broken benches, and rusty chainlink fences—will increasingly seem out of character and in need of attention. Through the continuing support of our friends, what has become a program of character restoration throughout the Arboretum will soon reach these areas of neglect and return them to the state of beauty that Sargent and Olmsted intended.

New Staff

Jon Hetman



Dan March is the Arboretum's apprentice for 2001–2002. Though his duties include curation as well as work in the greenhouses and on the grounds, his major focus is studying fifteen cultivars of invasive plants to determine the effects of different cultural regimes on seed germina-

Upcoming Events

The Art of the Japanese Garden: A Symposium, May 4, 2002

As part of the month-long Japan Festival in Boston, the Japan Society of Boston and Arnold Arboretum of Harvard University will co-sponsor a special symposium on The Art of the Japanese Garden. Japanese gardens and garden design principles have long been of interest here, and Asian species of trees, shrubs, and flowers have been introduced in America over the past two centuries. The Arnold Arboretum has devoted much of its activity to studying, recording, and preserving plants of Asian origin.

This symposium will bring together leading Japanese and American landscape designers to present their work in film, slides, and lectures and to discuss adapting classic Japanese garden designs to American settings. Speakers will include Patrick Chassé, landscape designer; Shinichiro Abe, garden designer and president of Zen Associates in Sudbury, Massachusetts; Julie Moir Messervy, writer and landscape design consultant; Stephen Morrell, garden designer and curator of the Humes Japanese Stroll Garden in Locust Valley, New York; and Yoshiaki Nakamura, architect and president of Nakamura Komuten in Kyoto, Japan.

The program will open with a screening of the award-winning documentary film *Dream Window: Reflections on the Japanese Garden*, written and produced by Peter Grilli, president of the Japan Society of Boston.

For more information, please call Pamela Thompson at 617.524.1718 x 162. Participants must register by April 22.



Sheryl White

Lilac Sunday, May 12, 2002

A celebrated harbinger of spring, Lilac Sunday marks the peak of the blooming season for the Arboretum's world-renowned collection of lilacs. Walking tours highlight plants with outstanding characteristics, and staff members dispense advice on planting and pruning. Enjoy picnicking (on this day only), entertainment, refreshments, and a surplus of beautiful sights and scents.

tion and their propensity to revert to the original species. Dan, who served as an Arboretum intern this summer, is from Afton, Minnesota. He received the degree of bachelor of science in horticulture from the University of Wisconsin-River Falls last spring.

Jon Hetman



Sara Straate, also a member of the 2001 internship program, began a yearlong assignment as curatorial assistant in September. Sara, who grew up in Waukon, Iowa, studied horticulture and design at Iowa State University. Her current position, funded by a grant from the Institute of Museum and Library Services, involves integrating the databases of the Arboretum's herbarium and living collections, cataloging Arboretum accessions, and preparing collection specimens from the grounds.

Jon Hetman



Anne Jackson has joined the Arboretum as membership coordinator. Anne comes to us from the Massachusetts College of Art where she served as development assistant and stewardship coordinator. She has long-standing interests in nonprofit fundraising, environmental issues, and the arts.

As membership coordinator, Anne will oversee data management and member services.

Jon Hetman



Melanie Schori is the new editorial assistant to Arnold Arboretum associate Campbell Webb, helping him to prepare a field guide to the trees of Borneo. The field guide will include commercial, ethnobotanical, and distributional information about all the major genera of trees on the island. Melanie earned her bachelor's degree in plant science from Cornell University. Her main interest is plant taxonomy and systematics. In

addition to her research and editorial duties, she will serve as curatorial assistant for the Farlow Herbarium.

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expedition to Tibet in 2000. (See Susan's article on this expedition in *Arnoldia*, vol. 61, no. 2.) The committee, chaired by Joan Morthland Hutchins, welcomed new members A. David Davis, co-chair of the Arboretum's Director's Advisory Board; Michael Donoghue, professor at Yale's department of ecology and evolutionary biology; Richard Primack, professor at Boston University's biology department; and Richard Schulhof, director of Descanso Gardens in Pasadena, California, and former director of public programs at the Arboretum.

The committee is scheduled to reconvene at the Arboretum in April 2003.

Yong-chan Park, 1974–2001

Public horticulture lost one of its brightest young champions last July when Yong-chan Park, a 1998 Arnold Arboretum intern, died at age 27 in a swimming accident in Pasadena, California.

After receiving his bachelor of science degree in landscape architecture at Yeungnam University in South Korea, Yong-chan was an intern at Chollipo Arboretum in Taean-Gun. His internship at the Arnold Arboretum marked the beginning of his education in American horticultural practices. In the spring of 1999, he began a two-year internship at Descanso Gardens near Los Angeles, working mainly in plant curation and exercising his abundant skills in mapping and labeling plants.

To advance public horticulture in Korea and build connections between his native and adopted countries, Yong-chan founded the International Public Horticulture Society (IPHS) as a vehicle for sharing horticultural ideas globally. The inaugural issue of its quarterly journal, *The Bridge*, was published in March of 2000. At the time of his death, Yong-chan had just completed the paperwork for making IPHS a nonprofit organization.

Colleagues at the Arboretum remember Yong-chan for his congeniality, his strong work ethic, and his tremendous enthusiasm for his chosen profession. The infectious nature of that enthusiasm is reflected in the determination of his IPHS associates to continue pursuing his vision for a global dialogue in horticulture.

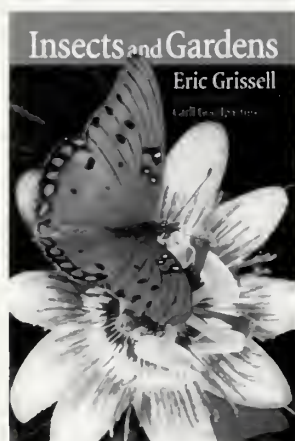
The Arnold Arboretum's Education Department offers many short courses, lectures, and programs to encourage individuals to appreciate and understand science and the natural world. Spring is a remarkable time to visit the Arboretum and take advantage of its wide array of educational offerings.

For more information on these and other programs, or to receive a complete catalog of programs and events at the Arboretum, call Pamela Thompson at 617.524.1718 x 162.

HOR 234 Bugs, Balance, and Biodiversity:

The Garden as Ecology

Eric Grissell, Research Entomologist, USDA



A garden is a humanly contrived, artificial construct of plants from all over the world, generally assembled with little regard for ecological or biological principles. We imagine that we control the garden, and we despair when age-old principles of ecological balance demonstrate the contrary.

Thus begins an unnecessary war between gardener and garden that seldom can be won.

In this talk, entomologist Eric Grissell suggests that we could reach a truce with our gardens if we worked within the laws of ecology. Insects, like the soil, are an essential part of a garden's structure and should be included in every gardener's plan. By seeking to increase, rather than limit, the biological diversity of flora and fauna, we can develop gardens that function as balanced systems. If we root our gardens firmly in the groundwork that nature has established they will provide more enjoyment and demand less work. Eric Grissell's new book, *Insects and Gardens: In Pursuit of a Garden Ecology* will be available for purchase and signing.

Fee: \$15 for members/\$18 for others

Thursday, April 25 @ 7:00-8:30 pm

(Hunnewell Building)

(MCLP: 1 credit)

Eric Grissell works as a research entomologist for the USDA in Washington, DC. He is the author of Insects and Gardens: In Pursuit of a Garden Ecology, Thyme on My Hands, and A Journal in Thyme, as well as numerous scientific papers.

HOR 116 Trees by Genus

Michael Dosmann, Putnam Fellow, Arnold Arboretum

An especially wonderful attribute of the Arboretum is its design, which makes it easy to study closely related woody plants. In this series of outdoor classes, the rich plant collection available to us will be used to examine some of the best-loved groups of trees. Each session will feature a single genus, or in the case of the oaks and beeches, two related genera. Walks will include a general overview of each group followed by an intensive survey of its diverse species. The classes will focus upon identification features, cultural requirements, landscape usage, and other aspects of their natural history.

Unless otherwise noted, each session will meet at the Hunnewell building. You may register for the series or for individual classes. The series will count as a required course for the Letter of Participation in Temperate Woody Plant Materials.

A. April 27: *Malus*, the crabapples

B. May 18: *Acer*, the maples

C. June 1: *Tilia*, the lindens

D. June 15: *Quercus* and *Fagus*, the oaks and beeches

E. July 13: *Betula*, the birches

Fee: \$18 for members/\$22 for others per class or for the series, \$90 for members/\$108 for others

Saturdays, April 27 (Meet at the top of Peters Hill), May 18, June 1, 15, July 13 @ 1:00-3:00 pm (Hunnewell building)



Acer saccharum

Michael Dosmann





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Jamaica Plain, MA 02130-3500

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Front cover: A species of *Cecropia* growing in Ecuador's Amazon Basin, clearly showing the tree's modular construction. As trees age, the modules that define their architecture repeat themselves, becoming smaller and more numerous. All cover photographs by Peter Del Tredici

Inside front cover: The trunk of a bristlecone pine, *Pinus aristata*, growing on Mt. Evans in the Rocky Mountains accommodating the presence of a dead branch.

Inside back cover: Environmental stresses can have a profound influence on the form of a tree. In the case of this *Ginkgo biloba*, those stresses arise not only from nature but from humans.

Back cover: An unusual case of nutrient recycling in red oak, *Quercus rubra*. Originally, a wound was covered with callus growth that eventually pushed its way inside the rotting wood of the trunk. The callus tissue formed a mushroom-like structure to fill the cavity, which eventually developed adventitious roots. These roots are clearly "recycling" nutrients from its own moist, rooting heartwood.



Gestalt Dendrology: Looking at the Whole Tree

Peter Del Tredici

The most remarkable thing about trees is how they develop and change over time.

Every year they add height and girth in a flush of new growth. They are forever expanding, from the bottom to the top and from the inside to the outside—a tree that is not expanding is a tree that is dying. The growth of trees is totally different from that of vertebrate animals, which tend to reach their full developmental potential relatively early in life, and then maintain themselves in the mature stage for as long as possible. To put it another way, animals are closed and entire in their development while trees are open and expansive.

The easiest way to visualize what is meant by open development versus closed is to look at the different approaches to dealing with bodily injury. In trees, if a limb is broken off, then so be it; the trunk will grow around the break and attempt to cover over the dead branch by producing callus tissue that grows inward from the outer edges of the wound. In many cases, the tree will also produce a new branch just below the location of the old one. Some people call this response wound-healing, but in reality the tree is simply walling off the damaged or dead tissue—compartmentalizing it—in an effort to protect the undamaged portions of the trunk. Dead tissue embedded within the trunk is of little consequence so long as rot does not spread into the living wood (Shigo 1986). Mammals, of course, cannot tolerate the presence of dead tissue within their bodies. If they are to survive, they must repair the injured body part; growing a new one is not an option.

Understanding what trees are and how they grow is central to the discipline known as *tree architecture*, which was developed during the 1970s by a Frenchman, Francis Hallé, a Dutchman, Roulof Oldeman, and an Englishman (and Harvard professor), Barry Tomlinson. As these



Wound healing revealed in the trunk of an unidentified conifer that is supporting a porch in downtown Skagway, Alaska. The naked wood clearly shows the complex interlocking grain that forms where the branch is attached to the trunk, as well as where wound-healing callus tissue has been produced after the branch died.

three scientists have defined the field, tree architecture describes the processes that regulate the growth and development of trees. Contrary to the meaning of the term *architecture* when applied to buildings, tree architecture is about dynamic change in tree form over time; it is not about the static, geometrical shapes of mature

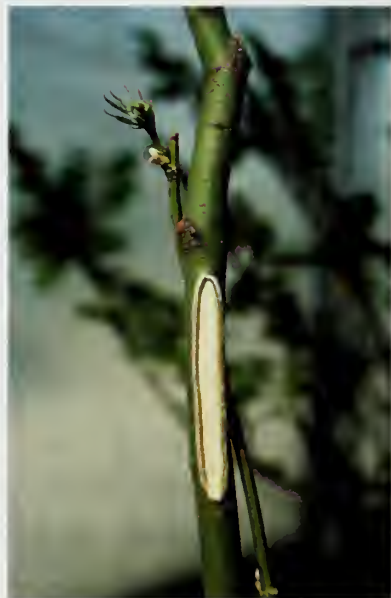
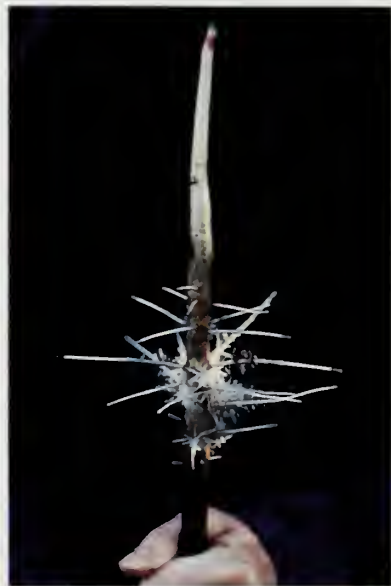
*The distinctive, “layered” architecture of the pagoda dogwood, *Cornus controversa*, growing at the Arnold Arboretum. This type of model is displayed by many understory trees found in temperate, deciduous forests.*

trees seen in field guides. To put it another way, tree architecture describes how trees develop their shapes, not what shapes they display. The discipline is particularly exciting because it deals with trees holistically, as intact, well-integrated organisms that are greater than the sum of their parts. Compared to most modern biology with its fixation on DNA sequencing, tree architecture takes a refreshingly nonreductionist approach to development.

The Meristem

Meristem is the term used for the specialized tissue that allows trees to continue expanding throughout their entire life span. This meristematic tissue produces the leaves, the stems, the flowers, the bark, and the roots—the differentiated tissues of the plant—while remaining undifferentiated itself. What makes meristematic tissue unique is that it exists in a perpetually embryonic state that allows the tree to be reborn every spring throughout its entire life.

Four different types of meristems are produced by trees. The most obvious one is the *shoot meristem*, or growing point, which is located at the heart of every bud on every tree. On a mature specimen oak, for example, there can be thousands, if not tens of thousands of buds, each with a tiny dome of embryonic tissue that is the meristem. Shoot meristems produce leaves, flowers, and primary twigs. Located at the tip of



Tree growth is continuously embryonic, with meristematic centers localized in the shoot and root tips and in the vascular and cork cambiums. Clockwise from top left:

Expanding buds of Fraser's magnolia, *Magnolia fraseri*, showing prominent, foliaceous stipules that protect the expanding leaves. All leaf tissue, as well as floral, is produced by the shoot meristem.

The primary and lateral roots of the red mangrove, *Rhizophora mangle*. The brackish water the tree grows in makes it easy to observe the branching of the root system.

The cambium layer of the Japanese maple, *Acer palmatum*, made visible by the growth of wound-induced callus following a botched attempt at grafting.

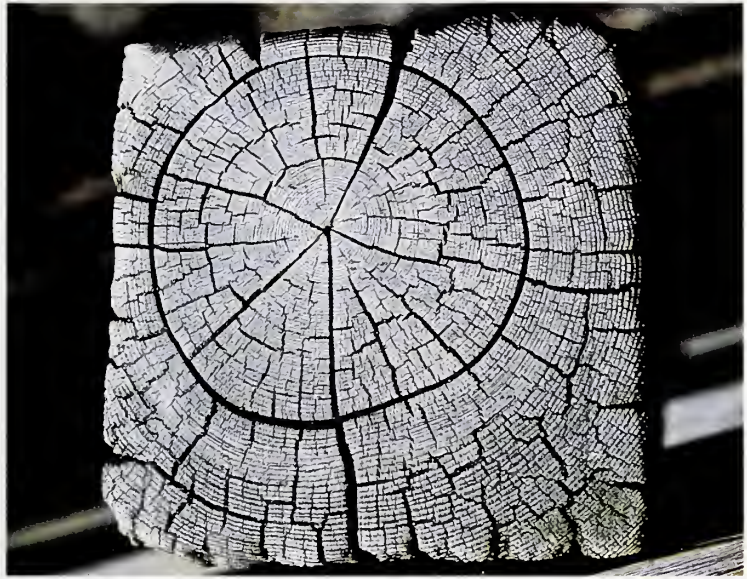
The dramatic, exfoliating bark of the paperbark maple, *Acer griseum*. The more extensive the cambium growth, the more extensive the exfoliation.

every root—and again, there are thousands of root tips on a mature tree—is a *root meristem* that, over time, produces the tree's massive, underground root system.

The third type of meristem is the *vascular cambium*, a column of tissue that sheaths the trunk, the branches, and the roots of the tree, and is responsible for the secondary increase in girth in all these parts. The vascular cambium is basically a gigantic cylindrical meristem that outlines the periphery of the entire tree and produces the wood that forms the bulk of the tree. When injury—such as that broken branch mentioned earlier—exposes the cambium layer to the elements, it is the vascular cambium that produces the callus tissue that overgrows the wood. The last type of meristem found in trees is the *cork cambium*, which produces the bark that protects and insulates the tree. In general, the growth of the cork cambium keeps pace with the growth of the vascular cambium, sloughing off the old layers of bark as it produces new ones.

Whereas the specialized cells that compose meristems retain their full developmental capacity throughout the life of the tree, cells in mammals can express their full developmental potential only in very young embryos. As the mammalian embryo ages, a liver cell can only produce a liver cell and a brain cell a brain cell. This closed system of development, which limits the potential of any given cell early in its life span, stands in contrast to the open system of plants, in which cells located at the periphery of the plant body retain their full developmental potential throughout the life of the tree. Theoretically speaking, a tree's life span is limited only by environmental disaster or predation by other organisms (Kaplan and Hagemann 1991).

A direct consequence of the meristematic structure of trees is that everything that has ever happened to them over the course of their long lives is embedded in the very fiber of their being, which is to say, the structure of their wood. The growth rings in nontropical trees are the foot-



*A fence post from lodgepole pine, *Pinus contorta*, in Yellowstone National Park, clearly showing the variation in annual growth rings.*

prints of vascular cambium activity, with each ring accurately recording the amount of growth a tree makes in any given year. Because tree growth is mostly a function of rainfall, the width of an annual growth ring provides an indirect measure of the moisture available to the tree that year. Scientists have used the information embedded in the width of growth rings to recreate past rainfall patterns that go back, quite literally, thousands of years (Cohen 1998). Similarly, for trees that shed portions of their bark in discrete plates, such as london planes, *stewartias*, and ponderosa pines, the size of the plates that are sloughed off each year serve as an indirect measure of the trunk's expansion: the greater the cambium expansion the larger the plates. Bark patterns are distinctive for each species.

Growth Rings and Goethe

Growth rings and bark plates are just some of the more obvious indicators of the principle that everything that happens to a tree over the course of its life is embedded in its form. To put it another way, both the external and internal structure of trees are manifestations of basic physiological processes. It was the German poet, philosopher, scientist Johann Wolfgang von Goethe who developed this concept and pioneered its use in science. The word he coined for this type of analysis—morphology—is still



Tree growth is structurally optimized to promote stability and to reduce mechanical stress on all parts.

*Left, bristlecone pine, *Pinus aristata*, interacting with a rock on Mt. Evans in the Colorado Rockies.*

Above, a close-up of the pine at left, showing the adaptive growth that the tree produced in order to deal with the immovable rock.

in use today. Morphology, literally, is the study of the development of form. Indeed, it was Goethe who, in 1790, first published the revolutionary idea that the various components of flowers are actually modified leaves—an idea that modern genetic analysis has come around to supporting some two hundred years later (Arber 1950; Kaplan 2001).

Goethe's ideas about morphology have mostly been forgotten by modern science, but they can be powerful analytical tools for anyone who takes the time to learn how about them. Indeed, within the field of mechanical engineering Goethe's concept of "reading nature" is making a comeback thanks to the development of sophisticated computer programs that can accurately model the dynamic growth processes of living organisms.

What these models demonstrate is that the growth of a tree is responsive to external stimuli, especially light, water, gravity, and

wind, and that these responses are embedded in the tree's external form. For trees, the problem is balancing the need to expand its surface area as it searches for light and water with the need to remain stable in relation to the force of gravity. In the real world, where destabilizing forces abound, the necessity for expansion is often in conflict with the necessity to remain upright. Trees have resolved this dilemma by employing a process known as *adaptive growth*, which allows trees to add extra tissue (i.e., wood) to reinforce those parts of the trunk that are overloaded, while ignoring those parts that are underloaded. To put it another way, adaptive growth allows trees to structurally optimize their trunks, branches, and roots in order to reduce the chances of mechanical failure under conditions of extreme loading such as wind, snow, and ice.

By carefully studying the growth of trees, Claus Mattheck, a professor of biomechanics at

the University of Karlsruhe, and his colleagues have developed a sophisticated computer program—known as Computer-Aided Optimization, or CAO—that accurately describes the growth of real trees in real situations. By adapting this program to industrial design problems, engineers are now able to analyze the stresses experienced by various machine parts that tend to break frequently and to “grow” new parts that add extra material only to locations where it can have the greatest impact in terms of reducing mechanical stress. In other words, they reinforce only those sections of the part that typically fail as opposed to making the entire part heavier. It is a remarkable and important engineering breakthrough that specifically mimics the adaptive growth processes that trees use to minimize the stresses they experience in their natural habitats.

From Meristems to Modules

Another consequence of the meristematic nature of trees is their *modular growth*, a concept that refers to the construction of a tree through the repetition of uniform structural units. For every tree, these basic modular units remain consistent through its life and are composed of a segment

of stem that produces leaves, branches, and—when sexually mature—flowers. When trees are young, the modular units that they produce are relatively large in size and few in number. As trees age, however, the modular units become smaller and more numerous, resulting in an increasingly finer and more ramified network of branches, as seen on the cover of this issue.

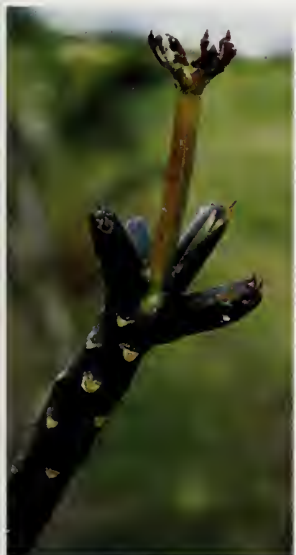
Every tree species has its own characteristic module that helps to define its architecture. Hallé, Oldeman, and Tomlinson have identified twenty-three models that describe the architecture of all known trees—



A striking example of reiteration in tulip poplar, Liriodendron tulipifera, growing at the Arnold Arboretum. It was probably induced by a dramatic increase in light following the death of a nearby specimen of the same species.

both tropical and temperate—based on the branching pattern of their twigs and on the position of their flowers. While somewhat theoretical in concept, these architectural models are useful in categorizing the known array of growth forms displayed by trees. Relatively few of the twenty-three models are required in order to describe the vast majority of temperate trees.

One corollary of the modular nature of tree growth is that most trees have the capacity to repeat their basic architectural model during the course of their lives. Such repetition of the basic model can happen either because of traumatic injury to the tree's framework, or because the tree is experiencing conditions that are particularly favorable to its growth. Regardless of the cause, such *reiteration*, as it is called, is an important part of tree growth in a world fraught with diseases, insects, snow, ice, drought, and hurricanes that threaten the health and stability of trees.



The basic architectural “module” in frangipani, Plumeria rubra, consisting of a terminal inflorescence and four subtending branches.



A twisted white spruce, *Picea glauca* var. *albertiana*, in Canada's Banff National Park, showing the effects of several episodes of snow-loading and recovery.

At its most basic level, the process of reiteration allows trees to expand indefinitely when conditions are good, or to start over after they have been severely damaged. Following this logic to its conclusion, one can say that trees, as they age, have the potential to develop into a colony of reiterated subunits, linked together by a common trunk and root system. Under extreme conditions, some trees that sucker from the base of the trunk literally fragment into segments that develop their own roots systems and establish complete autonomy from their original parent (Del Tredici 2001).

In order to reconstruct the history of any given tree, it is particularly important to be able to recognize the occurrence of reiteration, even if one don't know what type of event induced the reiterative response. On the negative side, it might have been caused by a weather event, a biological attack, or some human intervention. On the positive side, reiteration could be the result of being grown in full sun as a specimen tree or being exposed to additional sunlight following the death of a nearby dominant tree.

At the risk of sounding anthropomorphic, one might say that the shape of an individual tree is analogous to the personality of a human, being the product of the complex interaction between genetic endowment (nature) and environmental pressures (nurture). Quite literally, everything that ever happens to a tree in the course of its long life is embedded in its form, even the little things that might have happened to the tree when it was just a sapling. The body language of trees speaks not only to the influence of the past in the present, but also to the promise of the future.

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Peter Del Tredici is director of living collections at the Arnold Arboretum.

John Adams, Farmer and Gardener

Corliss Knapp Engle



U.S. DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE, ADAMS NATIONAL HISTORICAL PARK

The "Old House," the Adamses' home in Quincy, Massachusetts, painted by E. Malcom, ca. 1798.

The role that gardens played in the private lives of George Washington and Thomas Jefferson is well documented, but less is known about the gardening interests and activities of our second president, John Adams. Like most Americans of his time, John Adams began life with the heart of a farmer rather than a gardener, but in the course of traveling in the United States and in Europe he developed an appreciation of ornamental gardens that inspired efforts to imitate many of their features

at his own home. Adams had no influence on the White House garden, however; he spent only four months there, as its first occupant, from November to March of 1800–1801, and had time only to ask that a vegetable garden be planted before his failure to win reelection forced him to return to Massachusetts.

John Adams' childhood was spent hunting, fishing, and exploring the wilds of what is now called Quincy, south of Boston. He loved his family farm, and the influence of his early expe-



The unfinished Signing of the Treaty of Paris, 1783, by Benjamin West. The artist began with portraits (left to right) of John Jay, John Adams, Benjamin Franklin, Henry Laurens, and William Temple Franklin. However, the British commissioners refused to pose.

riences in the outdoors stayed with him throughout his life. Early in his working life he wrote for the *Boston Gazette* and *Boston Evening Post* as "Humphrey Ploughjogger," extolling the virtues of the farming life and urging the cultivation of hemp, *Cannabis sativa* (marijuana), for the manufacture of cordage and cloth; high on the list of actions he wanted Congress to take in 1771 was promoting hemp for use in making duck.¹ He also referred to hemp's mind-altering capability, writing, as Ploughjogger: "Seems to me if grate Men dont leeve off writing Pollyticks, breaking Heads, boxing Ears, ringing Noses and kicking Breeches, we shall by and by want a world of Hemp more for our own consumshon."² He described hemp's culture in great detail, explaining how to propagate it, how to treat the seed, and how to harvest the mature plant.³

As a farmer, Adams was naturally interested in increasing the fertility of his land, and theories about compost pepper his letters. (He shared this interest with George Washington, who recorded his experiments with compost over

more than thirty years.) In 1771 he wrote a recipe for compost that would delight organic gardeners today. Ingredients include "20 loads of sea weed, i.e. Eel Grass, and 20 Loads of Marsh Mud, and what dead ashes I can get from the Potash Works and what Dung I can get from Boston, and What Rock Weed from Nat. Belcher or else where." This mixture, combined with livestock waste, weeds, and kitchen scraps "in the Course of a Year would make a great Quantity of Choice manure."⁴ In a letter to his wife Abigail during one of his many absences over the years, he wrote that he was leaving the farm's management to her good judgment and the advice of those working for the family, but instructed her to "Manure in hills if you think best, but manure your barley ground and harrow it well."⁵

As the Revolution wore on into the late 1770s, Adams was appointed to a variety of consular posts in Europe. Taking a break from his duties in London in 1786, he took a walk, inspecting on the way a piece of land belonging to a "cow keeper." "These Plotts are plentifully manured," he wrote in his diary. "There are on the side of the Way, several heaps of Manure, an hundred Loads perhaps in each heap. I have carefully examined them. This may be good manure, but is not equal to mine." In France he went twice to see the gardens of the writer Boileau, which he estimated to be five or six acres in size. "It is full of Flowers and of Roots and Vegetables of all Kinds, and of Fruits. Grapes of several sorts and of excellent Quality. Pears, Peaches, etc. but every Thing suffers for want of Manure."⁶

Separations were many and long in the lives of Abigail and John Adams, and we've profited from those separations in their diaries and letters. Nonetheless, John could not always find time to write as often as he—and Abigail—would have liked, and she often complained about it. His answer to one such complaint bespoke his sense of priorities: "Suppose I should undertake to write the Description of every Castle and Garden I see as Richardson



COURTESY OF MOUNT VERNON LADIES ASSOCIATION

The East Front of Mount Vernon painted by Edward Savage, ca. 1792. The ha-ha built by George Washington is marked by the brick wall that cuts across the lawn in the foreground. Adams may have learned about this garden feature from Washington.

did in his Tour through Great Britain, would not yoo blush at such a Waste of my time."⁷ But Adams did enjoy his garden visits and wrote approvingly of the ornamental "pleasure grounds" of England and France.

Remarking on a French garden, he wrote: "The Shade, the Walks, the Trees, are the most charming that I have seen." In another garden, seeing a collection of rocks that "[had been drawn] together at vast Expense," Adams offered to sell the owner "1000 times as many for half a Guinea" from his fields in New England. (This humorous comment was no mere jest, since the hills of Quincy were at that time a major source of granite for construction in Massachusetts.) Visiting an ornate castle garden, complete with grottoes and water spouts, Adams took delighted interest in the fish ponds, where carp and swans swam over to be fed. "Whistle or throw a Bit of Bread into the water, and hundreds of Carps, large and fat as butter, will be seen swimming near the top of the water towards you . . . Some of them then will thrust up their Mouths to the Surface, and gape at you like young birds in a Nest to their Parents for Food."⁸

From time to time, however, these European gardens aroused the moralist in Adams. While on an excursion outside London with Thomas Jefferson, he was charmed by the greenness and the bird songs of Osterley, the Middlesex country house of Robert Child, but he remarked that these country homes were "not enjoyed by the owners . . . They are mere Ostentations of Vanity." He felt that the English "temples to Bacchus and Venus are quite unnecessary as mankind have no need of artificial Incitements," and hoped that English-style gardens would never become fashionable in America because "Nature has done greater Things."⁹

Nevertheless, back home in 1796 he succumbed to his own desire for "ostentation of vanity" by installing in Quincy a feature popular in England at the time, the ha-ha.¹⁰ Used to create the effect of a long vista uninterrupted by fencing, with livestock grazing peacefully in the distance, the ha-ha is a banked ditch, five or six feet wide and five to seven feet deep. The higher bank of the ditch, closest to the house, is supported by a wall of planking or masonry and conceals a fence that keeps the cattle and sheep away while giving the impression that they can

wander freely onto the house lawn. Perhaps Adams learned about the ha-ha from George Washington, who had one built at Mount Vernon. Ha-ha's can still be seen today in Virginia horse country.

Adams seems to have overcome his moral objections to English garden fashion during the years he spent in Philadelphia serving as vice president (1789-1797). There, he and Mrs. Adams leased a small house from William Hamilton, a wealthy man of property whose large estate, The Woodlands, was laid out in the "natural" English manner and planted with unusual native and exotic trees and shrubs. Yet even during this period, Adams remained a farmer at heart. He shared his interest in soil improvement with John Rutherford, the U.S. senator from New Jersey, who told him all about lime, which "dissolves all vegetable Substances, such as Leaves, Straws, Stalks, Weeds, and converts them into an immediate food for vegetables. It kills the Eggs of Worms and Seeds of Weeds. The best method is to spread it in your Barn Yard among the Straw and Dun," and added a warning: "The German farmers say that Lime makes the father rich, but the Grandson poor i.e. exhausts the Land."¹¹

John Adams did not have the passionate interest in large trees that was to provide the focus of garden-building for his son John Quincy. On the Quincy farm, Adams' practice was to trim or remove trees to keep the land open for crops and livestock, and he appreciated trees mainly for their economic value. Writing in his diary about a grove of red cedars, he noted that the "prunings would be good browse for Cattle in Winter and good fuel when the Cattle have picked off all they will eat."¹²

Adams nevertheless was very observant of trees during his travels and often commented on them in his letters and diaries. When he stayed at The Hide in Middlesex while in England in 1786, Adams noted that the grounds "are full of rare Shrubbs and trees, to which Collection America has furnished her full Share, [including] Larches, Cypruses, Laurels."¹³ Abigail, who had joined him on this visit, wrote in a letter that their host "called his tall cypress General Washington and another by its side Colonel Smith as his aide-de-camp."¹⁴

Adams remarked on the lack of trees everywhere in France but in the parks. To him, a "country of vineyards without trees . . . has always [seemed] to me an appearance of poverty."¹⁵ American forests impressed him both as signs of the richness of nature and as an economic resource. While riding the circuit in coastal Maine as a young lawyer in 1765, he noted with wonder "all the varieties of the Fir, i.e., Pines, Hemlocks, Spruces, and Firs." His description of a felled hemlock he found lying across a road evokes the vast forests of the East Coast that are now gone forever: "They had cutt out a logg as long as the road was wide. I measured the Butt at the Road and found it seven feet in Diameter, Twenty one feet in circumference. We measured 90 feet from the Road to the first Limb." He estimated the tree to have been 130 feet tall.¹⁶

Although absent from Quincy for most of his working life, Adams kept his emotional roots firmly planted there. In 1787 he and Abigail purchased the Old House in Quincy, where, following his defeat in 1801 for a second presidential term, he would spend the remainder of his life. In January 1794 he wrote: "I begin now to think all time lost that is not employed in farming; innocent, healthy, gay, elegant amusement! Enchanting employment! How my imagination roves over my rocky mountains, and through my brushy meadows."¹⁷ Three years later, miserable with a cold and sounding like quite the gentleman farmer, he wrote: "Oh! My poor meadow and wall, etc. etc., etc. It would do me good like a medicine to see [my gardener] one hour at any sort of work."¹⁸

Naming a garden has always been a fashionable custom. In 1796, at the end of a gloriously happy summer in Quincy, John Adams proposed to name the land around the Old House "Peacefield," for the sense of peace he enjoyed there, but also in commemoration of the peace he had helped to win for his country in 1783 and to preserve for the thirteen years following.¹⁹ However, upon his unhappy return in 1801 he instead called the property "Stony Field, Quincy," an appropriate name given the rocky soil of the area. After he and Thomas Jefferson had mended their broken relationship in 1812, he jokingly began referring to his property as



A modern view of the "Old House" in the Adams National Historical Park maintained by the U.S. National Park Service.

"Montezillo," which he translated as "Little Hill" in contrast to the "Little Mountain," Jefferson's Monticello. (The distinction is purely fanciful, of course. The root in both cases is "monte," meaning either hill or mountain in both Spanish and Italian.) Today the property is called the Old House and is part of the Adams National Historical Park maintained by the U.S. National Park Service.

However much their land may have been a working farm with fields and orchards, John and Abigail Adams enjoyed having ornamental plants near the house. When they purchased the Old House, long triangular beds to the southeast were bordered with low hedges of *Buxus sempervirens* (common boxwood) and planted with fruit trees. These boxwood-lined beds exist today, though their plantings were changed from trees to perennials by succeeding generations of Adamses. After 1800, Adams planted one or two specimens of horse chestnut in front of the house.²⁰ We must assume they were the European horse chestnut, *Aesculus*

hippocastanum, which came to the United States via England in 1741. In 1821 those horse chestnuts shaded the two hundred West Point cadets who rested on the grass after their seven-mile march from Boston, while the 86-year-old former president addressed them from the porch of the Old House.²¹

Some of the ornamentals from the time of John and Abigail Adams still exist today at the Old House. According to family lore, the clump of *Magnolia virginiana* (sweet bay magnolia) next to the front wall was planted by Abigail.²² A black willow, *Salix nigra*, grows at the very edge of the property, close to where the Furnace Brook runs. Because of its age, and because black willows persist from rootstock, it is highly probable that this very tree is the one Abigail mentioned in a letter to her sister on April 7, 1800: "The verdure of the feilds

[sic] and the bursting of the Buds, with the foilage of the weeping willow, which you have heard me admire and which is the first tree to vegetate in the spring, all remind me of Quincy, my building, my Garden."²³ In a later letter she remarked on the "gracefulness of its slender branches which float and wave to every breeze."²⁴

The white York rose, *Rosa x alba*, which Abigail Adams brought back from England in 1788, still grows at the Old House from cuttings propagated over the years. A European rose known from at least the sixteenth century, it is seldom seen in gardens today, but in 1917, the Arnold Arboretum's first director, Charles Sprague Sargent, wrote of his plans to propagate it for Mount Vernon. He considered it "a very appropriate plant for the Mount Vernon garden both historically and because Washington might very well have had it in his garden."²⁵

Other plants that John and Abigail enjoyed do not survive. Writing to his granddaughter's husband in 1817 regarding a gift the couple had made to him, Adams observed: "You would be

pleased to see the pritty Figure your Peach Trees and Cherry Trees make in my Garden. Their buds are at least a fortnight more forward than any of our native Trees. I hope you will contrive to come and see them next fall. Be sure and bring the Sprightly Elizabeth with you. Tell her never to forget how her great grandfather smoked his Segar."²⁶ The peach and cherry trees are gone, but the "sprightly" Elizabeth is remembered as the wife of Andrew Jackson Downing, the nurseryman and landscape gardening theorist.

Certainly Adams was no landscape gardener on the scale or with the intensity of George Washington or Thomas Jefferson; the ha-ha was his first and last gesture toward "ostentation of vanity." Perhaps with greater means he would have done more, as Abigail suggested in a letter, saying "he cannot indulge himself in those improvements upon his farm, which his inclination leads him to, and which would serve to amuse him, and contribute to his health."²⁷ Still, his farmer's heart and his creative intellect come together in an observation that remains true to this very day. In a letter to Abigail he muses, "Mr. Madison is to retire [from Congress]. It seems the mode of becoming great is to retire. Madison, I suppose, after a retirement of a few years, is to be President or Vice President . . . It is marvellous how political plants grow in the shade. Continual daylight and sunshine show our faults and record them. Our persons, voices, clothes, gait, air, sentiments, etc. all become familiar to every eye and ear and understanding, and they diminish in proportion, upon the same principle that no man is a hero to his wife or valet de chambre."²⁸

Endnotes

- ¹ John Adams, *Diary and Autobiography of Adams*, ed. L. H. Butterfield (Cambridge, Mass.: Belknap Press of Harvard University Press, 1961), 2:234.
- ² "Humphrey Ploughjogger," in *Boston Evening Post*, June 20, 1763, copy in Massachusetts History Society, Boston.
- ³ Adams, *Diary and Autobiography*, 1:249.
- ⁴ *Ibid.*, 2:49.
- ⁵ John Adams to Abigail Adams, April 3, 1794, *Letters of John Adams Addressed to His Wife*, ed. Charles Francis Adams (Boston: Charles Little and James Brown, 1841), 2:151.
- ⁶ Adams, *Diary and Autobiography*, 3:194; 3:146.

- ⁷ John Adams to Abigail Adams, February 26, 1779, *The Book of Abigail and John: Selected Letters of the Adams Family 1762-1784*, ed. L. H. Butterfield, M. Friedlaender, and Mary-Jo Kline (Cambridge: Harvard University Press, 1975), 241.
- ⁸ *Ibid.*, 2:316; 2:314; 3:35.
- ⁹ *Ibid.*, 3:189; 3:186.
- ¹⁰ *Ibid.*, 3:231.
- ¹¹ *Ibid.*
- ¹² *Ibid.*, 2:88.
- ¹³ *Ibid.*, 3:197.
- ¹⁴ Abigail Adams to John Quincy Adams, September 27, 1786, *Letters of Mrs. Adams, The Wife of John Adams*, ed. Charles Francis Adams (Boston: Charles C. Little and James Brown, 1840), 2:154.
- ¹⁵ Adams, *Diary and Autobiography*, 4:40.
- ¹⁶ *Ibid.*, 3:281.
- ¹⁷ *Letters of John Adams Addressed to His Wife*, ed. Adams, 2:139.
- ¹⁸ *Ibid.*, 2:251.
- ¹⁹ Adams, *Diary and Autobiography*, 3:247.
- ²⁰ Helen Nelson Skeen, "Documentary Narrative of Buildings Shown on Historic Base Map of the Adams National Historic Site," report prepared for the National Park Service (1964), 51.
- ²¹ Josiah Quincy, *Figures of the Past* (Boston: Little, Brown, & Co., 1926), 77-78.
- ²² Skeen, 58.
- ²³ Abigail Adams to her sister Mary Cranch, Philadelphia, April 7, 1800, *New Letters of Abigail Adams, 1788-1801*, ed. Stewart Mitchell (Boston: Houghton Mifflin, 1947), 244.
- ²⁴ Abigail Adams to Mary Cranch, Philadelphia, April 16, 1800, Adams Papers, microfilm edition, Massachusetts Historical Society, Boston, reel 391.
- ²⁵ Charles Sprague Sargent to Miss Comegys, July 9, 1917, Archives of the Mount Vernon Ladies' Association, Mount Vernon, Virginia.
- ²⁶ John Adams to his granddaughter's husband, John P. DeWint, May 1, 1817, Cedar Grove, near Fishkill, N.Y., John Adams Letter Book, Adams Papers, reel 123.
- ²⁷ Abigail Adams to Thomas Boylston Adams, November 13, 1800, *Letters of Mrs. Adams*, 2: 237.
- ²⁸ John Adams to Abigail Adams, January 14, 1797, *Letters of John Adams Addressed to His Wife*, 2:240.

Corliss Knapp Engle has been an enthusiastic gardener and flower show exhibitor in the Boston area for nearly thirty years. She photographs, lectures, and writes for horticultural organizations across the country, and has served as chairman of the Garden History and Design Committee of The Garden Club of America. This is an adaptation of an article first published in *White House History* with the permission of the White House Historical Association.

The Discovery and Rediscovery of the Horse Chestnut

H. Walter Lack

We have only to imagine Paris in May without the blossoming horse chestnuts (*Aesculus hippocastanum*) lining its avenues to appreciate a statement attributed to Thomas Jefferson: "The greatest service which can be rendered to any country is to add a useful plant to its culture." It was not until the sixteenth century that the horse chestnut was cultivated outside the Ottoman Empire, but once the first twigs and seeds had arrived from Istanbul, it quickly found its way into gardens throughout western Europe and is now in cultivation in temperate regions all over the world.

The horse chestnut's native distribution is restricted to the Balkan peninsula; however, knowledge of its native habitat remained confused until the late nineteenth century, with most botanists believing its origins to be in Asia. Linnaeus, for example, wrote in 1753 that the horse chestnut grows in the more northern regions of Asia; and the tree's common name in French—*marronnier d'Inde*—still refers to a supposed Asian origin. In fact, so strong was the belief in the Asian origin of horse chestnut that in the early 1800s, when the report of an Englishman's discovery of horse chestnut growing wild in the Pindus Mountains of Greece was published, it was not believed; and it was not until eighty years later that the Balkan origin of horse chestnut was finally accepted.

The Introduction of Horse Chestnut to Western Europe

The first written report on the horse chestnut is found in a letter that Willem Quackelbeen (1527–1561) wrote from Istanbul in 1557 to Pietro Andrea Mattioli (1501–1578), a physician then living in Prague. Quackelbeen was at the time physician to Augier Ghiselin de Busbecq (1522–1592), ambassador of Ferdinand I, the Holy Roman Emperor, to Sultan Suleyman II, "the Magnificent," under whose reign the Otto-

man Empire had reached the climax of its political and military power, extending at that time through most of the Balkan peninsula and including all of what is now Hungary as well as parts of modern Romania, Slovakia, Moldavia, and Ukraine. Quackelbeen's letter to Mattioli includes the following statement:

A species of chestnut is frequently found here [in Istanbul], which has "horse" as common second name, because devoured three or four at a time they [the horse chestnuts] give relief to horses sick with chest complaints, in particular cough and worm diseases.

Since the horse chestnut does not occur naturally in Istanbul or its surroundings, Quackelbeen was almost certainly referring to a tree cultivated in Istanbul, where it is still popular today and where many specimens of considerable size can be seen. Mattioli's answer to Quackelbeen, dated Prague, 4 December 1557, includes several questions concerning the novel tree and implies that Quackelbeen may have included seeds with his letter.

Earlier, Mattioli had written about Quackelbeen's finding to Ulysse Aldrovandi (1522–1605), a well-known naturalist who in 1567 would become co-director of the newly founded botanic garden of the University of Bologna. In his 1561 letter to Aldrovandi in Bologna, Mattioli mentioned specifically the "very large leaf consisting of five leaflets" and wrote that "the fruit [seed] does not differ much from our common chestnut [*Castanea sativa*], but is only somewhat more round." This may indicate that Mattioli had also received a branch of the horse chestnut from Quackelbeen or a drawing based on it, since leaf characters are not mentioned in Quackelbeen's letter.

The first printed illustration of the horse chestnut was published by Mattioli in Prague in 1563. It is a woodcut included in his *New Kreüterbuch*. The accompanying text merits



From Joseph Jacobi Plenck, *Icones Plantarum Medicinalium*, Centuria III, published in Vienna, 1790.

attention: "There is also another foreign genus of chestnuts which I have had depicted here because of its beautiful form. The very famous Augherius [Ghiselin de Busbee], the legate of the Christian Emperor at Istanbul, has sent me this twig with fruit from there. It is a tall tree, it has leaves similar to those of the castor bean plant [*Ricinus communis*], they have six splits down to the petiole, which is long and thin. The spiny shells are similar in size to ours [those of *Castanea sativa*], but they are yellowish, in each of them there is a chestnut thicker and

rounder than ours. The rind [testa] of this chestnut is blackish with the exception of the front part where it is attached to the spiny shells, where it is whitish and has the form of a heart. Below this rind there is no further skin as is the red wrinkled skin of ours. They taste nearly like ours, but sweeter and not so good to eat. The Turks call them horse chestnuts because they help panting horses." Mattioli thus provided an excellent description and a good comparison with a tree he knew well; born in Siena and later living in Gorizia, near the border that separates modern Italy from Slovenia, he must have been familiar with the European sweet chestnut from childhood. It is clear from the woodcut that unripe fruits of the horse chestnut were used for the drawing; and since Mattioli describes the testa as blackish, it may indicate discoloration of the immature fruits when dry. The possible sources of the materials used for Quackelbeen's description and for the woodcut are of interest because they bear on the question of when and where the horse chestnut was first cultivated in Western Europe. A close study of the material in various archives provides some clues.

The first clue appears in the introduction to Mattioli's *New Kreüterbuch* of 1563. In it the author thanks his correspondents for sending plant material, the first mentioned by name being Jacob Anton Cortuso (1513–1603), a patrician of Padua and later the fourth prefect of the Padua Botanic Garden. Cortuso reported in 1563 that he had sent a drawing of the horse chestnut from Padua to Ulysse Aldrovandi in Bologna. This drawing may have been based on a specimen that Cortuso had received from the Levant, but it is not impossible that Cortuso already had a cultivated specimen in his garden.

Another correspondent mentioned by Mattioli was Ulysse Aldrovandi himself. In Aldrovandi's famous *Erbario Dipinto*, also called *Iconographia Plantarum* and now at the

Biblioteca Universitaria in Bologna, we find an illustration of the horse chestnut annotated "Kananon Ippeion. Castanea sativa." This watercolor is a precise match of the woodcut published in Mattioli's *New Kreüterbuch* and may be either a copy of the woodcut, the pattern on which the woodcut was based, or a copy of the pattern. Whichever it was, one aspect of the woodcut and of its twin, the Bologna watercolor, remains enigmatic: since both illustrations show a fresh specimen (in the watercolor of the *Erbario Dipinto* the leaves are painted greenish), the drawing could not have been made from material transported by sixteenth-century means from Istanbul to either Vienna or Bologna; after a journey of that duration the horse chestnut twig would have arrived wilted, if not totally dry. It seems that the illustrator either worked in Istanbul and sent his painting to a correspondent in the West (Mattioli in Prague, Aldrovando in Bologna, Cortuso in Padua, or someone else); or he worked in the West, managing to make a dried twig appear alive or using a live specimen already growing there. Available documents do not allow us to know which of these possibilities is correct.

However, Aldrovandi's herbarium, kept today at the Istituto Botanico of the University of Bologna, contains yet another clue: a leaf of the horse chestnut annotated "Castanea equina flore albo." This specimen can neither be dated nor the provenance given, but it must have been incorporated into the herbarium prior to Aldrovandi's death in 1605, making it one of the oldest leaves of this species in existence. It may have been sent to Bologna by one of Aldrovandi's correspondents in the Ottoman Empire, but it may also have come from a tree cultivated in western Europe—in Bologna itself, or in Cortuso's Padua, or perhaps in Florence, in the garden of the Duke of Tuscany, where Jean Bauhin (1541–1612), another famous physician and naturalist, mentions having seen a horse chestnut, apparently before 1569. (In fact, a short biography of Bauhin written in 1963 mentions that he had visited the Tuscany region in 1562.)

No city, however, has better documented evidence for cultivation of the horse chestnut at an early date than Vienna. Clusius, a court servant



Κάναλον Ιππεϊον

Castanea equina

Aesculus hippocastanum L. illustrated in *Ulysse Aldrovandi's Erbario Dipinto*, Vol. 5, f. 167, ca. 1560.

of His Roman Imperial Majesty Maximilian II, gives us the background in his *Rariorum aliquot stirpium historia*, published in 1583. Writing about *Prunus laurocerasus* (cherry laurel), Clusius says that a specimen "was sent here [to Vienna] from Istanbul at the beginning of the year 1574, and again in the year 1581 . . . Maybe two years later, at the beginning of January 1576, I received from the very famous David Ungnad, Imperial Ambassador to the Emperor of the Turks, his small tree." The implication is that living trees were indeed transported in winter from Istanbul to Vienna, no doubt on the backs of horses, mules, or camels.

Four pages later Clusius reports on the horse chestnut: "I have not seen its flower or fresh fruit; it was brought here [to Vienna] from Istanbul in 1581 under this name [castanea equina]." Since Clusius describes the unfolding of the leaves in spring, there must have

been a living specimen in cultivation in Vienna at that time—and one may assume that *Aesculus hippocastanum*, like *Prunus laurocerasus*, had originally been sent there by David Ungnad Graf von Weissenfels (d. 1601), one of Busbecq's successors as ambassador to Istanbul. From capitals like Vienna and Florence or towns with famous botanic gardens like Padua and Bologna, horse chestnuts could be quickly distributed to other regions in central and western Europe, as was indeed the case.

Rediscovery in the Wild

Little is known about the discovery in the 1790s of horse chestnut growing in its native habitat by John Hawkins, a many-sided gentleman traveler from Cornwall. His diaries and notes were ruthlessly burnt in 1903 (although his correspondence survived) by the owner at that time of Bignor Park, Hawkins' residence in Sussex, and the only known reference to his finding the horse chestnut is the cryptic note "*Ae. Hippocastanum* . . . In Pindo et Pelio montibus. D. Hawkins," found in the *Florae Graecae Prodrromus*, published in England in 1806. Did Hawkins visit these two mountains situated in the remote parts of modern Greece and, if so, at what time?

A letter from Hawkins to his mother dated 14 September 1795 shows that he had visited the mainland of Greece in the late spring of 1795, and a note in one of his archaeological papers published many years later (1820) makes it clear that he had been as far as "Yannina" (Ioánnina, in the center of the peninsula), which is very near the Pindus Mountains and within the range of the horse chestnut's natural distribution. It is

SEMANTICS

Balkan semantics are complex: several languages are spoken in the area; for many centuries four scripts were used; and all Balkan languages comprise many words taken over from other tongues. This last observation applies to the common name of the horse chestnut. The similarity between the fruits of the widespread sweet chestnut and of the much more local horse chestnut is reflected in the common names of the latter. In its native area the following names are used:

Serbia: *divlji kesten*, wild chestnut; *beli divlji kesten*, white wild chestnut; *gorki kesten*, mountain chestnut

Macedonia: *divlji kesten*, wild chestnut

Greece: *hippocastanon*, horse chestnut

Bulgaria: *konski kesten*, horse chestnut

Albania: *gështenja e kalit*, horse chestnut

Surprisingly, Quakelbeen's association of *Aesculus hippocastanum* with horses has also survived in most languages spoken outside the Balkan peninsula—in the German *Roskastanie*, spelled today almost precisely as it was spelled by Mattioli in 1563; in the English horse chestnut; and in the Italian *ippocastano* and *castagno equino*. Among the few exceptions to the general rule are the French *marronnier d'Inde* and Italian *castagno d'India*, both of which reflect the earlier belief in a more easterly habitat. It should be noted, however, that seventeenth-century sources give *chastagne de cheval* as the French name for the horse chestnut, indicating that the nomenclatural association of the tree with India is of a more recent date.

there that he probably first encountered this spectacular tree. A record of a visit by Hawkins to Mount Pilon also exists, found among the recollections of James Thoburn, his servant. In this region, which according to Thoburn he visited in late spring of 1797, Hawkins may have seen the horse chestnut again. And, while passing a second time through the contemporary province of Epirus in the spring of 1798 on his way from Mesolongion via Ioánnina to Durrës in modern Albania, Hawkins may have seen natural stands of the horse chestnut yet a third time. Hawkins is not known to have collected herbarium material of the horse chestnut, however, and although his finding was properly

published in the *Florae Graecae Prodrumus*, the botanical community did not believe it, no doubt remembering earlier errors in the literature. Even well-known dendrologists like Carl Koch (1809–1867), then at the University of Berlin, believed the horse chestnut to be native to regions much further east, such as the Himalayas, and a specialist of the Balkan flora, Heinrich Rudolf August Grisebach (1814–1879), professor of botany at the University of Göttingen, did not even mention Hawkins' claim in his *Spicilegium florae rumelicae et bithynicae* (1843–1844). Edmond Boissier (1810–1885), on the other hand, mentioned Hawkins' discovery only to refute and even misattribute it. He wrote in his monumental *Flora orientalis* (1867) that the horse chestnut had allegedly been found growing wild "in the mountains of northern Greece . . . by Sibthorp [read Hawkins], but I have nowhere seen spontaneous specimens. Probably originating in the mountains of India, everywhere cultivated." It was only in 1879, more than eighty years after Hawkins' discovery, that Theodor von Heldreich (1822–1902), then director of the botanical garden in Athens, was able to confirm it. In 1878, the Treaty of Berlin that followed the Russo-Turkish War had resulted in parts of modern Greece (Thessaly and the southern part of Epirus) being ceded by the Ottoman Empire to the Kingdom of Greece. Heldreich made use of this change in Balkan affairs to visit the area, still wild and unsafe, in the summer of 1879. Since his report, published in Berlin in 1880, comprises the first known description of the horse chestnut's native habitat, it is quoted here at length:

When my guide Nikitas told me in the Chelidón Mountains in Evritanía of a "species of wild chestnut" growing in a ravine in the lower zone of the silver fir I thought of the *Castanea vulgaris*, sometimes common here, the wild form with its smaller fruits here called "wild chestnut," in contrast to the pruned variety with bigger fruits, but since he stated the leaves also to be different, the fruits very bitter and not to be eaten, I did not shy at the detour any more. How great was my surprise to see here in the wilderness on rocky outcrops of a ravine a group of horse chestnut trees covered with half-ripe fruits! . . . All these localities are situated in the

lower zone of the silver fir, at an altitude of 1000 to 1300 m [3,300–4,250 feet]. They are shady, more or less humid ravines amidst woods.

Heldreich lists five localities, all in "Eurytanien" and "Phthiotis," where he was convinced that the horse chestnut was truly wild and indigenous, growing "in the most remote, uninhabited mountain regions." He even reports the common name then used among the Greeks of the area (wild chestnut) as well as the local use of the fruits, which were fed to horses to cure them of a cough. A specimen collected by Heldreich and kept in the Naturhistorisches Museum in Vienna corroborates this second rediscovery; it is labeled "Evritanía, on Mount Chelidón in the silver fir zone above the village Mikrochorio, c. 1000–1750 m. [3,300–5,800 feet], spontaneous in shady ravines, at a locality called Kephaloovysi, 11 August 1879."

It should be noted that in its native habitat the horse chestnut is never found as the solitary, monumental tree of considerable age that is so common nowadays in parks and gardens, but as one of the many elements of a mesic wood and not growing to be very old; this may explain the difficulty of finding it in the wild. In subsequent years (1950, 1980, and again in 1990) the ecology of this tree has been studied repeatedly and Heldreich's report confirmed many times. In May of 1881, central Greece was also transferred from the Ottoman Empire to the Kingdom of Greece, resulting in yet more confirmations of Heldreich's rediscovery and more searching in adjacent areas for *Aesculus hippocastanum*. In 1883 it was Georgios I, king of Greece, visiting his new provinces accompanied by a "Mr. Munter, director of the royal estates." The latter confirmed Heldreich's report—in the steep valley of the river Arakthos and on the southern slopes of the Pindus Mountains they, too, observed natural stands of the horse chestnut.

H. Walter Lack is Professor of Botany at the Freie Universität Berlin and Director at the Botanischer Garten und Botanisches Museum Berlin-Dahlem. This article is adapted from his "Lilac and Horse-Chestnut: Discovery and Rediscovery," *Curtis's Botanical Magazine* (2000) 17(2): 109–137, with the kind permission of the publisher.

Aesculus hippocastanum: The Handsome (and Useful) Horse Chestnut

Klaus K. Loenhardt

E H. Wilson, plant collector, connoisseur of trees, and keeper of the Arnold Arboretum, once wrote that "if a census of opinion were taken as to which is the most handsome exotic flowering tree in the eastern part of the United States there is little doubt but that it would be overwhelmingly in favor of the Horsechestnut."¹ Certainly my vote for the most exotic flowering tree *anywhere* would go

to *Aesculus hippocastanum*: it was the first tree species to catch my attention when I was a child and later acquaintance has only strengthened my attachment. Perhaps the most striking feature of the tree is its blossoms: upright candelabra distributed in a pattern of almost geometric precision throughout the towering mounds of foliage. My childhood interest was only incidentally related to the flowers however. I grew up in

ARCHIVES OF THE ARNOLD ARBORETUM



Aesculus hippocastanum on the banks of the Thames, Cookham, England, photographed by E. H. Wilson in the 1920s

the countryside of Bavaria, where as kids we collected huge numbers of horse chestnut seeds to feed to deer during the winter.

Later I became familiar with the horse chestnut in another context. An unwritten rule in Bavaria decrees that the horse chestnut—and *only* the horse chestnut—must be planted in all beer gardens, both to provide shade and to demonstrate that the establishment properly upholds the traditions of beer and beer gardens. Horse chestnut trees, many of them the variety *Aesculus x carnea* 'Briotti', can therefore be found in all of the 172 beer gardens within the city limits of Munich—even those in the most crowded central area. The largest of them can be a hundred feet tall with a single tree sometimes shading the entire garden.

The horse chestnut, rather than some other tree, became the symbol of Bavarian beer gardens for several good reasons. It is easily raised from seeds; it can be transplanted without great difficulty if the seedlings are properly handled; it is adaptable to a range of pH values; and it grows rapidly. Not least, its flowering season, in mid May, coincides with the beginning of the beer garden season, which draws huge crowds of people into the breweries' outdoor spaces.

But the very specific preference for horse chestnut also has historical roots. Beer gardens were founded around 1720, when the brewing industry began to flourish. Because brewers needed to keep huge amounts of ingredients on hand, they built underground vaults to provide the required space and moisture. Constant temperatures are critical during storage, and since *Aesculus hippocastanum* comes into full leaf just as the May sun begins to heat up the ground, groves of horse chestnuts were planted on top of the cellars to guarantee consistent temperatures in all seasons. Thus, Bavaria's beer gardens became some of the first rooftop gardens known, and the horse chestnut an early device for passive air conditioning.

Because the horse chestnut has been so successfully grafted onto the important tradition of



KLAUS K. LOENHART

the beer garden, most Bavarians assume that it is a native species. *Aesculus hippocastanum* is native to the Balkan peninsula, however, and was not introduced in western Europe until the mid 1550s, where it was quickly adopted. In 1664 John Evelyn was writing, "This tree is now all the *mode* for the Avenues to their Countrey Palaces in *France*."² And it has not lost favor in Europe despite its many shortcomings, as noted by John James in 1712:

I cannot deny but the Horse-Chestnut is a handsome Tree; 'tis certain it grows very upright, has a fine Body, a polish'd Bark, and a beautiful Leaf; but the Filth it makes continually in the Walks, by the Fall of its Flowers in the Spring, its Husks and Fruit in the Summer, and its Leaves in the Beginning of Autumn, mightily lessens its Merit: Add to this, that it is very subject to May-Bugs and Caterpillars . . . that it grows but to a moderate Stature, lasts but a very little while, and that its Timber is of no manner of Profit.³

It is true that the wood of the horse chestnut has little or no commercial value: it is soft, lacks strength and durability, and burns badly. Furthermore, it does not cut cleanly and decays rapidly. Nor are horse chestnuts used in reforests-



tation, being considered "principally unimportant forest trees, with light, soft, coarse-grained, perishable wood."⁴

But ever since the horse chestnut was introduced, Europeans have found countless uses for it. In the form of charcoal, its wood has provided both fuel and gunpowder. Tanners and dyers (yellow) have used the bark, and its grated nuts will bleach flax, hemp, silk, and wool. An infusion of horse chestnuts will expel worms from the soil and kill them when soaked in it. Vermin find highly offensive the combination of a powder of its dried nuts with alum-water. Add to that combination two parts of wheat flour and you have a strong paste for bookbinding.

It is reported that when the horse chestnut's fruits are given to cows in moderation, both the yield and the flavor of their milk is enhanced. Bavarian deer relish the horse chestnut's fruits, but before pigs will ingest them, they must be steeped in lime-water.⁵ Humans too find it hard to get excited about their taste. Nevertheless,

during World War II the nuts were roasted and combined with various kinds of grain for use in *Ersatzkaffee* (coffee substitute). Today *Ersatzkaffee*, still containing roasted horse chestnuts, is offered at high prices in Germany's eco-stores. It would be unthinkable in Bavaria, but in Ireland the aromatic young buds have been used in beer as a substitute for hops.

Those uses aside, perhaps the greatest demand for the tree's products has come from pharmacology. The horse chestnut's seeds and bark have long been widely used in European traditional medicine, and a visit to a medical database such as BIOSIS will show that the practice continues today, chiefly for relief from edema but also for hemorrhoids. Extracts of horse chestnut are also recommended for certain cosmetic problems, among them cellulite and hair loss. Another extract of the bark has been shown to protect against UV damage, chiefly because of its antioxidizing properties. And I should add a use that the scientific literature does not mention. My own great-grandmother ferments the nuts for a liquor that yields not only alcohol but also serves to relieve arthritic pain.

E. H. Wilson made the case for the beauty of *Aesculus hippocastanum*. I hope I've made a convincing, if not exhaustive, case for its usefulness, and that if a census of opinion were to be taken as to which is the most *useful* exotic flowering tree, if not in the eastern part of the United States then in Europe, you would find ample reason to vote for the handsome horse chestnut.

Endnotes

¹ *The Romance of Our Trees*, 1920.

² *Silva: Or, A Discourse of Forest-Trees*.

³ A. J. Dezallier d'Argenville, *Theory and Practice of Gardening*, translated by John James, 1912.

⁴ George Rex Green, *Trees of North America*, 1934.

⁵ *The Encyclopaedia Britannica*, 11th ed., vol. VI, 1910.

Klaus K. Loenhardt is a practicing landscape architect and architect. He holds a diploma in architecture from the FHM Architecture School in Munich, as well as master's degrees in architectural theory and in landscape architecture, both from the Harvard Design School.

THE HORSE CHESTNUT

ACCOLADES FROM CHARLES S. SARGENT

The forerunner of *Arnoldia* was titled *Bulletin of Popular Information*.¹ Its purpose was to call attention “to the flowering of important plants and other matters connected with them.” Initially published every Saturday during spring and autumn and from time to time during the remainder of the year, Charles S. Sargent wrote every issue of the *Bulletin* from its inception in 1911 to the year before his death in 1927. Not until 1918 did he feature *Aesculus hippocastanum*, when he included it in a review of large exotic trees that he could recommend for the northern United States for ornament or timber. He concluded that “from the experience gained in Massachusetts during about a century” only about twenty had proved themselves worth planting.² From then on he expressed his admiration for the horse chestnut annually and enthusiastically.

No American Horsechestnut or Buckeye can compare in size or in the beauty of its flowers with the species of southwestern Europe (*Aesculus hippocastanum*), which is well known to many Americans who have never heard there were Horsechestnut-trees growing naturally in the United States. The European Horsechestnut is another of the great trees of the world. It is as much at home here and grows to as large a size as it does in western Europe. Few trees have more conspicuous flowers or foliage of deeper green. . . .

When it is covered from top to bottom, as it is this year in the neighborhood of Boston, with its great erect clusters of white flowers, it is the most splendid object among the trees hardy in the northern states. . . . The finest plant in the neighborhood of Boston known to



LIBRARY OF THE ARNOLD ARBORETUM

E. H. Wilson photographed Salem's acclaimed horse chestnut in 1925.



the Arboretum is in a garden in Salem, Massachusetts, believed to have been planted one hundred and ten years ago and now seventy feet high with a trunk ten feet in girth, and a perfectly shaped head eight feet across.

It was a favorite tree with Benjamin Bussey who bought his place in Jamaica Plain in 1806 and probably planted Horsechestnut trees there a little later. A few of them are on the walk which led from his house to Bussey Hill, and these are no doubt the oldest planted trees in the Arboretum.³

The European Horsechestnut only flourishes in deep cool soil, and although it has been largely used to shade city streets in this country and in Europe, it is not suited for such a purpose for the heat and drought of cities often cause it to lose its leaves in midsummer. Its place is in parks and gardens and by country roadsides.

¹ Arboretum director E. D. Merrill, a believer in one-word magazine titles, changed the name in 1941.

² Also on Sargent's list are ginkgo, european larch, three species of poplar, three willows and their hybrids, katsura, white mulberry, ailanthus, european beech, english elm, one birch, three lindens, and the norway maple.

³ The plant records of the Arnold Arboretum—although comprehensive from its founding in 1872 and now inclusive of some preexisting plants—say nothing about preexisting horse chestnuts except to note that the first *Aesculus hippocastanum* planted since the 1872 was propagated from seed collected on the grounds of the Bussey Institute (once part of Bussey's estate) and accessioned as number 266 in 1880.

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The Arnold Arboretum

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Long-Range Plan Heralds Organizational Changes

Robert E. Cook, Director

In July 2002, the Arnold Arboretum will undergo a very significant change following two years of long-range planning. The institution will be reorganized into four primary departments: Living Collections, Public and Professional Programs, Administration, and Research. Living Collections will be responsible for the curation and maintenance of the woody plant collection and grounds in Jamaica Plain. Public and Professional Programs will organize and execute all of our activities that provide educational and visitor services. As of July, this department will assume administrative responsibility for a professional landscape program that offers formal certificates upon completion of all requirements. This program was formerly the Radcliffe Seminars in Landscape Design and Landscape Design History, which will be transferred from the Radcliffe Institute for Advanced Study.

The third department, Administration, will consolidate all support functions, including facilities, finances, information technology, and personnel. Finally, a new department, with the tentative title of *Research*, will acknowledge a growing commitment to expand the institution's capacity to support scholarship and generate new knowledge about woody plants based on the collections of the Arboretum. Over the next decade

we will invest significant new resources in several research initiatives in collaboration with investigators at Harvard University and other institutions.

To help manage these significant changes, we have created a new senior position of Deputy Director who will be responsible for organizing the Public and Professional Programs department and for implementing the goals of our long-range plan. In September, this position will be filled by Richard Schulhof, currently director of Descanso Gardens in Los Angeles, California. Richard earned his undergraduate degree in landscape architecture at the University of California, Berkeley,

and spent a number of years in the nursery industry. After receiving a master's degree in public horticulture administration through Longwood Gardens in Pennsylvania, he worked for seven years at the Arnold Arboretum as a Putnam Fellow and as head of our educational programs before accepting the directorship at Descanso in 1996. We are immensely pleased to have him return to work with us on these exciting new plans.

I believe these changes herald a period of new growth and achievement for the Arboretum, one that would not be possible without the continuing support of our members and friends.

Peter Del Tredici



Cephalotaxus fortunei

PIPD Program Highlights New Plants for 2002

The Plant Introduction, Distribution, and Promotion (PIPD) program was established seven years ago to make available to nurseries, and eventually to gardeners, unusual plants with excellent ornamental potential that have proven stress tolerant and free of serious pests and diseases at the Arnold Arboretum. This year over 35 shipments of *Prunus depressa* 'Gus Melhquist', *Wiegela subsessilis*, and *Cephalotaxus fortunei* have been

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sent to nurseries, botanical gardens, and other woody plant evaluation programs.

Prunus depressa 'Gus Mehlquist'

Rob Nicholson, formerly of the Arnold Arboretum and currently at the Smith College Botanical Garden, and David Boufford of the Arnold Arboretum selected this prostrate sand cherry from a stand along the Connecticut River in New Hampshire. Native from New Brunswick to Quebec and Ontario, south to Massachusetts and New Hampshire, it is a very unusual deciduous woody groundcover of medium to rapid growth. Once established, it will reach 6 to 12 inches in height and several feet in width over a two-to-three-year period. It roots along its stems, increasing its ability to hold slopes. The dark green foliage of the growing season is followed by vibrant crimson fall color. Simple one-inch white flowers appear in May and are followed by blue-black fruits in September. Fruits are not showy and are often hidden by the foliage. It is best grown in full sun to partial shade in moisture-retentive soil. In its natural habitat it behaves like other floodplain species, tolerates spring floods as well as the summer droughts that follow. It is insect and disease resistant and hardy to USDA zone 4.

Weigela subsessilis

This weigela is native to South Korea and has been grown at the Arnold Arboretum since 1977 (AA accession # 1906-77). In contrast to other members of the genus, the flowers it produces in abundance in May are 2 to 3 inches in length and change color gradually from a pale yellow through various shades of pink to

pale lavender for a multicolored effect. The plants at the Arnold have reached 6 feet in height and width after 25 years. For best growth, they need full sun or partial shade and moisture-retentive soil, and for best flowering they require adequate moisture. Insect and disease resistant and hardy to USDA zone 5, the Korean weigela is a good ornamental shrub for borders or woodland edges.

Cephalotaxus fortunei

Fortune's plum yew, as this plant is commonly known, is native to central and eastern China. The Arnold Arboretum's accession 1846-80-A, the parent plant of the distributed clones, was grown from seed collected in 1980 by the Sino-American Botanical Expedition to western Hubei Province.

Some plants of this species become small trees, but this accession is a multistemmed shrub with dark evergreen foliage, 12 to 15 feet high and nearly as wide. Most striking are the needles, which vary in length from 2 to 4 inches and are 1/8-inch wide, flattened, with whitish stomatal bands covering the underside. Its habit is upright with side branches that tend to droop. The species is dioecious, and female plants produce 1 inch, bluish-green fruits that age to olive-brown. Hardy to USDA zone 6, it prefers moist, loamy soils, but tolerates heavy clay. Best grown in light shade, it has been reported to burn under full winter sun. It can be used as a specimen, for a mass planting or informal hedge; it does not attract deer. No serious problems are known.

Leventritt Garden Previewed at Flower Show



Steve Schneider

Visitors to the Arnold Arboretum's award-winning display at the 2002 New England Flower Show were dazzled by a sneak preview of the soon-to-open M. Victor and Frances Leventritt Garden of Shrubs and Vines.

Staff from the Living Collections department replicated a 240-square foot section of the garden, including 25 feet of fieldstone wall and trellis structures that supported *Clematis montana* var.

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New Gates Dedicated at Forest Hills

About 100 area residents celebrated the May 4th opening of the Blackwell Footpath, which spans the Stony Brook Marsh section of the Arboretum. Boston Mayor Thomas Menino, members of the Arboretum Park Conservancy, and Arboretum Director Robert E. Cook participated in the celebration.

The footpath, named for long-time Arboretum Park Conservancy member John Blackwell, provides an enjoyable walk between the Forest Hills MBTA station and the South Street gates of the Arboretum. The 24-acre parcel of land was formally added to the Arboretum in 1996 and has since been rehabilitated after years of neglect. In keeping with its wetland character, the landscape will remain semiwild.

Citizen volunteers organized the Arboretum Park Conservancy, Inc., in the mid 1980s to promote the Arboretum as a public park. The Conservancy encouraged the City of Boston and Harvard University to expand their public-private partnership by protecting the wetland and creating the footpath and gates.

Funding for the footpath's design and construction came from a Federal Transportation Enhancement grant matched by the Commonwealth of



Phyllis Andersen

Conservancy President Matthew J. Kiefer, joined by Boston Mayor Thomas Menino and Arboretum Director Robert E. Cook, addresses visitors at the new Forest Hills Gates.

Massachusetts and the City of Boston. Some 300 individual donors and several foundations and charitable trusts funded the gates at each end of the path.

James Arnold Society Spring Meeting

On May 10, 2002, members of the James Arnold Society joined Arnold Arboretum gardener Steve Schneider for a tour of the lilac collection. The tour, held two days prior to Lilac Sunday, showcased the collection at its fragrant and floral zenith. Participants were also given a preview of the Arboretum's new shrub and vine garden by director Bob Cook, followed by lunch in the Hunnewell Building.

The James Arnold Society, named for the Arboretum's great benefactor whose bequest enabled the creation of the Arboretum, recognizes those who have made life income gifts or bequest provi-

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Chris Santos

Arnold Society members enjoy a tour of the lilac collection with Arboretum gardener Steve Schneider.

Volunteers Lead Botanical Adventures for Children

Each year over 3,000 children come from metropolitan Boston classrooms to the Arnold Arboretum to learn about trees under the guidance of a crew of affable volunteers. The Field Study Experiences program, which celebrates its twentieth anniversary next year, gives children the opportunity to explore the landscape and observe natural phenomena in a uniquely structured way. Traveling in small groups led by trained adult volunteers, children can draw and write about trees and collect flowers and seeds. The program is based on hands-on experience with plants, encouraging children to open and look inside flowers and seeds or to return to their classrooms with collections of cones, needles, bark, and resin.

The Field Study Experiences are held in fall and spring. In the fall program—*Plants in Autumn: How Seeds Travel* or *Native Trees/Native Peoples*—students explore seed dispersal strategies using the collections along Meadow Road. They also visit the conifer section, learning to identify trees that supported the Eastern Woodland peoples who lived here in pre-colonial times. The spring program, *Flowers Change*, challenges students to discover what happens to flowers as they change into fruit.

Nancy Sableski, coordinator of children's education, is actively recruiting new volunteers for September training. Nancy observes, "People often express an interest in volunteering but worry that they don't know enough about

trees. The training will provide guides with all the information they need to lead a group. What I'm looking for are people who love children and the natural world. This is a wonderful program and a great way to gain more knowledge of our collections and to share that knowledge with children."

If you would like to learn more about volunteering as a school program guide this fall, please contact Nancy Sableski at 617.524.1718 x 163.

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rubens, forced into bloom for the exhibit. A variety of wild-collected plants as well as cultivars selected for horticultural interest filled the planting beds—among them, *Cercis canadensis* 'Covey', an eastern redbud with a weeping habit, and *Fothergilla gardenii* 'Harold Epstein', a dwarf form of fothergilla. Information about the garden, including views of architectural models, construction photographs, and a list of featured plantings, was also displayed.

A silver medal and a superior commendation certificate for recently introduced cultivars of plants were awarded by the Massachusetts Horticultural Society for the eye-catching exhibit.

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sions for the Arnold Arboretum. For more information, please contact either Anne D. McClintock, Executive Director, or Amy Goldman, Deputy Director, University Planned Giving, Harvard University, 124 Mt. Auburn Street, Cambridge, MA 02138-5762; 800.446.1277 or 617.495.4647; email: pgo@harvard.edu; www.haa.harvard.edu/pgo.

2002 Annual Fall Plant Sale

Sunday, September 15, 2002

The 22nd Annual Fall Plant Sale will be held at the Case Estates in Weston, Massachusetts, on Sunday, September 15, 2002. This year the sale returns to its origins as a benefit of membership and will be open only to Friends of the Arnold Arboretum. (If you are not a member, you may join on the day of the sale and immediately receive free plants.) A detailed catalog of sale offerings will be distributed to members this summer along with free plant vouchers.

All sale plants will be woody, Arboretum-grown material, displayed inside the Case Estates barn. Members at the sustaining level (\$100) and above will be admitted to the barn at 8 a.m.; all other members may enter at 9 a.m. Members of the Arboretum's



Living Collections department will be on hand to answer plant-related questions. As always, parking will be available directly across the road from the entrance to the Case Estates.

Rain or shine, we hope to see you there! If you have any questions or would like to join the Friends of the Arnold Arboretum, please contact Anne Jackson at 617.524.1718 x 165.





